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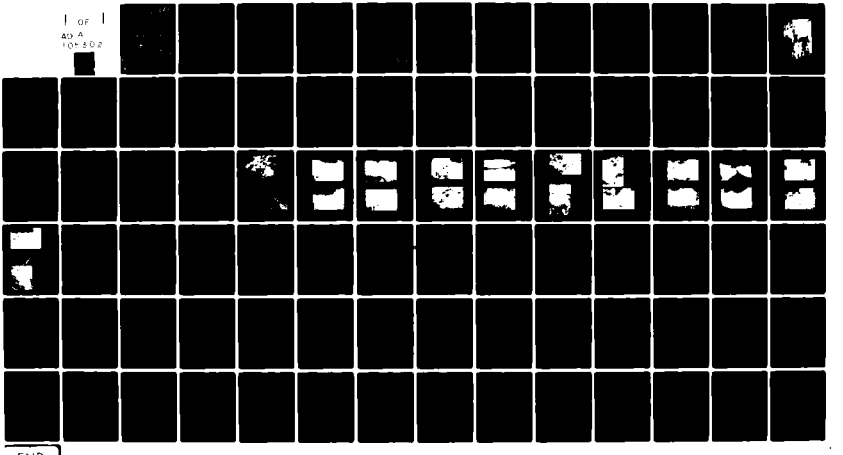

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MISSOURI-NEMAHA-NODAWAY BASIN

HALL DAM

ATCHISON COUNTY, MISSOURI

MO. 11038

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

JUNE, 1980

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.	

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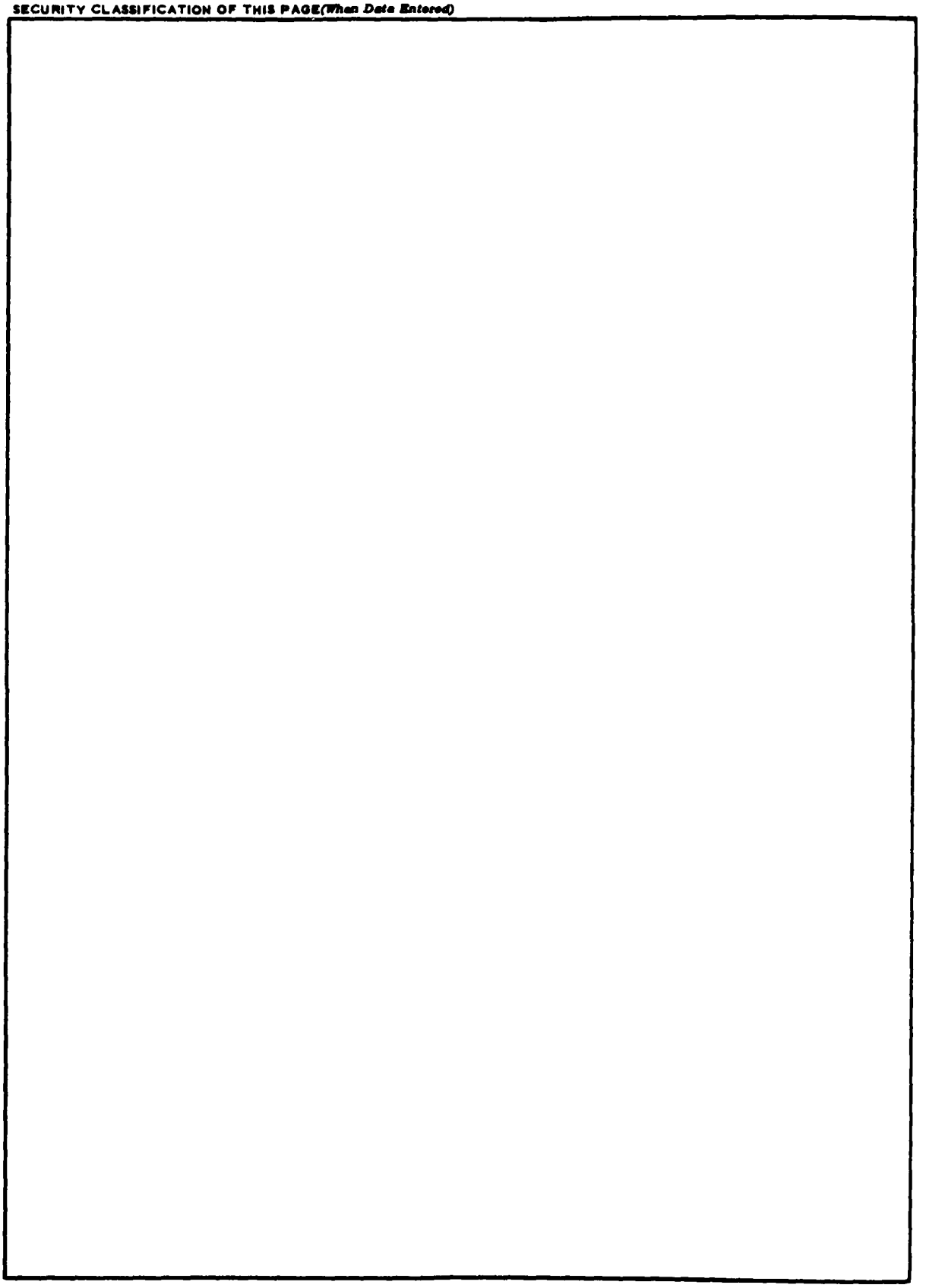

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☆ U.S.G.P.O. 1980-665-141 1299

HALL DAM
ATCHISON COUNTY, MISSOURI
MISSOURI INVENTORY NO. MO 11038

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

JUNE, 1980

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

LMSED-P

SUBJECT: Hall Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Hall Dam (MO 11038).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe-emergency by the St. Louis District because of seepage and a shear failure in the downstream embankment slope. These conditions pose serious threats to the integrity and safety of the dam under conditions approaching maximum impoundment level. Other unsafe conditions are:

a. Slump area over the principle spillway pipe (Photos 10-11).

b. The combined spillways will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

c. Obstruction in the entrances of the emergency and principle spillways (trees and a beaver dam).

SUBMITTED BY: SIGNED
Chief, Engineering Division

24 Sep 1980
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

20 Sep 1980
Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	Hall Dam
State Located	Missouri
County Located	Atchison County
Stream	Tributary to Rock Creek
Date of Inspection	June 5, 1980

Hall Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. The purpose of the inspection was to make an assessment of the general conditions of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers.

Hall Dam has a height of thirty (30) feet and a storage capacity at the minimum top elevation of the dam of thirty (30) acre-feet. In accordance with the guidelines, a small size dam has a height greater than or equal to twenty-five (25) feet but less than forty (40) feet and a storage capacity greater than or equal to fifty (50) acre-feet but less than one thousand (1,000) acre-feet. The size classification is determined by either the storage or height, whichever gives the larger size category. Hall Dam is classified as a small dam.

In accordance with the guidelines and based on visual inspection, this dam is classified as a small size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends about seven-tenths of a mile downstream from the dam through the center of Rockport to Rock Creek. Within the damage zone are five dwellings, two commercial buildings and State Highway 111.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the recommended guidelines for a small dam having a high hazard potential. Considering the small volume of water impounded and the downstream channel from the dam, one half of the Probable Maximum Flood is the appropriate spillway design flood. The spillways will not pass the 100-year flood (1% probability flood, a flood having a one percent chance of being exceeded in any year) without overtopping the dam. The spillways will pass 14% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

No design data were available for this dam. Based on the observations made during the field inspection of the dam, the following remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams:

a. Alternatives.

(1) The spillway size and/or the height of dam should be increased to pass 50 percent of the probable maximum flood without overtopping the dam.

b. Operation and Maintenance Procedures.

(1) In light of the owners report that the present reservoir capacity has been greatly reduced by siltation, it is recommended that additional studies be conducted to determine the potential downstream damage that might result from failure of this dam. These studies should include detailed topographic characteristics (stage-storage relationships) and water depths (present bottom elevations) of the reservoir area. A dam breach analyses should be conducted to determine the resultant downstream flood levels. This work should be done by a professional engineer experienced in the design and construction of dams.

(2) Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" should be performed. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) by a professional engineer experienced in the design and construction of dams.

(3) The causes of the slump over the spillway pipe, of the shear failures on the downstream slope, and of the seepage through the embankment should be determined and the necessary repairs made. The investigations to determine the causes of these deficiencies and the engineering design needed in order to make the repairs should be performed by a professional engineer experienced in the design and construction of dams.

(4) The trees should be removed from the slopes of the dam and from the entrance of the emergency spillway. Measures should should be taken to prevent recurrent growth. Trees in the exit channel of the emergency spillway and in the downstream channel are probably advantageous for erosion control and are not recommended for removal. Tree removal should be done under the guidance of a professional engineer experienced in the design and construction of dams.

(5) The beaver dam obstructing the principal spillway inlet should be removed. Measures should be taken to prevent reconstruction.

(6) A program of regular inspection and maintenance should be initiated for this dam.

Rey S. Decker
E-3703

Gordon Jamison

Garold Ulmer
E-19246

H. P. Hoskins
Harold P. Hoskins, Chairman of the Board
Hoskins-Western-Sonderegger, Inc.
E-8696

PHOTO NO. 1 - OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
HALL DAM - MO 11038
ATCHISON COUNTY, MISSOURI

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Hall Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams," Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams," dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth fill constructed in a deep, steep sided gully eroded in the deep loess hill country bordering the east side of the Missouri River flood plain in the northwestern corner of Missouri. The dam is approximately 145 feet in length with a maximum height of 30 feet. The maximum water storage at the minimum top elevation of the dam is 30 acre-feet.

(2) The principal spillway is uncontrolled and consists of a 24-inch diameter welded steel pipe which passes through the embankment. The pipe is equipped with a hooded inlet.

(3) An uncontrolled vegetated earth emergency spillway is cut through the left abutment.

(4) Pertinent physical data are given in paragraph 1.3 below.

b. Location. The dam is located in the west central portion of Atchison County just west of Rockport, Missouri. It is located in the SE 1/4 of Section 28, T65N, R41W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Hall Dam has a height of 30 feet and a storage capacity at the minimum top elevation of the dam of 30 acre-feet. This dam is classified as a small dam. A small dam has a height greater than or equal to 25 feet but less than 40 feet and a storage capacity greater than or equal to fifty acre-feet but less than 1,000 acre-feet. The size classification is determined by either the storage capacity or height, whichever gives the larger size category.

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph 1.1c above. Based on referenced guidelines and on visual observation, this dam is in the High Hazard Classification. The estimated damage zone extends about 3500 feet downstream from the dam through the center of Rockport to Rock Creek. Within the damage zone are five dwellings, two commercial buildings and State Highway 111.

e. Ownership. The dam is owned by Earl Hall, 705 Underwood, Rockport, Missouri 64482.

f. Purpose of Dam. Gully head cutting and erosion control.

g. Design and Construction History. The dam was constructed in 1972 by Sam Logson, Fairfax, Missouri (now deceased). Mr. Hall reported that the Agricultural Stabilization and Conservation Service (ASCS) provided some assistance in laying out the dam. No other information was available on design or construction of the dam.

h. Normal Operating Procedure. There are no controlled outlets for this dam. The level of the pool is dependent upon precipitation, runoff, and the capacity of the spillways. Mr. Hall reported that the emergency spillway has not operated.

1.3 PERTINENT DATA

a. Drainage Area. 189 acres (0.295 square miles).

b. Discharge at Damsite.

(1) All discharges at the damsite are through a principal spillway consisting of a 24-inch diameter welded steel pipe spillway and a grassed earth channel ungated emergency spillway.

(2) Estimated maximum flood -- unknown.

(3) The principal spillway capacity varies from 0 c.f.s. at elevation 979.1 feet to 47 c.f.s. at the crest of the emergency spillway (elevation 986.7 feet) to 53 c.f.s. at the minimum top of dam (elevation 989.2).

(4) The emergency spillway capacity varies from 0 c.f.s. at its crest elevation of 986.7 feet to 194 c.f.s. at elevation 989.2 feet (minimum top of dam).

(5) Total spillway capacity at the minimum top of dam is 247 c.f.s.±.

c. Elevations. (Feet above M.S.L.)

(1) Top of dam - 989.6± (989.2 Minimum).

(2) Principal spillway crest and normal pool - 979.1.

(3) Emergency spillway crest - 986.7.

(4) Observed Pool - 980.0.

(5) Maximum Experienced Pool - 984±.

(6) Streambed at centerline - 960±.

(7) Maximum tailwater - unknown.

d. Reservoir. (Length in feet)

(1) Pool at Principal Spillway - 300±

(2) Pool at Emergency Spillway - 500±

(3) Pool at Minimum Top of Dam - 950±

e. Storage (Acre-feet).

(1) Top of dam - 30±.

(2) Principal spillway crest and normal pool - 6±.

(3) Emergency spillway crest - 29±.

(4) Observed Pool - 8±.

(5) Maximum Experienced Pool - 15±.

f. Reservoir Surface (Acres).

(1) Top of dam - 3.6±.

(2) Principal spillway crest and normal pool - 1.5±.

(3) Emergency spillway crest - 2.8±.

(4) Observed pool - 1.5±.

(5) Maximum experienced pool - 2.1±.

g. Dam.

(1) Type - Earth fill.

(2) Length - 145 ft.±.

(3) Height - 30 ft.±.

(4) Top width - 14 ft.±.

(5) Side slopes.

(a) Downstream - 1 V on 2H ±.

(b) Upstream - 1 V on 3.5 H.

(6) Zoning - none

(7) Impervious core - none

(8) Cutoff - none

(9) Grout curtain - none

(10) Wave protection - none

h. Diversion Channel and Regulating Tunnel. None

i. Spillway.

(1) Principal

(a) Type - uncontrolled, 24-inch welded steel pipe with hooded inlet.

(b) Crest (Invert) elevation - 979.1± (M.S.L.)

Outlet - 961.5 (M.S.L.)

(c) Length - 118 ft.

(2) Emergency

(a) Type - uncontrolled, vegetated earth cut through left abutment.

(b) Control section consists of a level section about 30 feet long downstream from the ℄ of the dam.

(c) Crest elevation - 986.7 (M.S.L.)

(d) Upstream Channel - vegetated on inverse grade of 1 to 3%.

(e) Downstream Channel - vegetated, about 30 feet long on grade of 2.5%± dropping off sharply into the old channel.

j. Regulating Outlets. None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were available for this dam.

2.2 CONSTRUCTION

No construction data were available. It was reported by Mr. Hall that the dam was constructed in 1972 by Sam Logson. He also reported that one anti-seep collar was installed on the principal spillway pipe.

2.3 OPERATION

No data were available on spillway operation. It was reported by Mr. Hall that the emergency spillway has never operated. He also reported that the maximum water level in the pool was about elevation 985.5 (one foot below emergency spillway crest).

2.4 EVALUATION

a. Availability. No data were available.

b. Adequacy. The field surveys and visual observation presented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading condtions (including earthquake loads) and made a matter of record.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Hall Dam was made on June 5, 1980. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska making the inspection were: R. S. Decker, Geotechnical; Garold Ulmer and Gordon Jamison, Hydrology. Mr. Hall accompanied the inspection team.

b. Dam.

(1) Geology and Soils (abutment and embankment). The dam is located in the dissected till plains area of the Central Lowlands Physiographic Area. It is located in the deep loess hill country bordering the east side of the Missouri River, in a deeply incised, straight walled gully typical of deep loessal erosion in this area. Upland soils in the area consist of deep loess deposits (ML-CL) forming the Marshal-Knox soil association. Abutments consist of ML-CL loess. Foundation materials in the valley bottom consist of colluvium and/or alluvium derived from loess. No glacial till or limestone bedrock was observed at the site. Materials in the embankment consist of ML-CL loess borrowed from the abutment areas.

(2) Upstream Slope. The upstream slope is well vegetated with adapted grasses. Several trees, up to 8 inches in diameter, are growing along the water-edge of the slope. No erosion or deformation was noted on the upstream slope. Photo No. 2 shows the upstream slope.

(3) Crest. The crest is fairly well vegetated with grasses and weeds. Measurements shown on Plate C-1 indicate that the crest elevation is quite uniform. No cracks or deformations were observed on the crest. Photo No. 3 shows the crest.

(4) Downstream Slope. The downstream slope is poorly vegetated with grass, weeds and shrubs. Several small trees are growing on the slope, as shown in Photo No. 4. A slump or sinkhole is located over the principal spillway pipe (downstream from about station 1+10) about 4 feet vertically down from the crest. This slump is about 15 feet long (parallel with pipe), 6 feet wide and 3 to 4 feet deep. Mr. Hall reported that this same area slumped one or two years after the dam was built. It was filled and has slumped again. Photos 10 and 11 show the slump area over the pipe. A circular shear slide area occupies a large section of the downstream slope to the right of the spillway pipe approximately downstream from Station 1+10 to 1+40. The shear slide extends from about 6 feet (vertically) below the crest (10-12 ft. horizontally) down to the toe of the dam. The top of the slide is about 15 feet wide. The bottom is about 25 feet wide. Vertical displacement at the top of the

slide (scarp) is 2.5 to 3.0 feet. Photos 13 and 14 shown the slide area. Seepage outcrops in the lower section of the slide area at about elevation 965 or about 4 feet above the invert elevation of the pipe outlet. Seepage discharge from the area is estimated at less than 0.1 g.p.m. Seepage was clear at the time, but it appeared that a slight increase in head pressure could produce piping in the seepage exit area. Photo No. 12 shows a portion of the seepage exit area.

(5) Miscellaneous. Mr. Hall did not know when the slide occurred in the downstream slope. Maple tree seedlings growing in the upper (scarp) portion of the slide appear to be 3 or 4 years old.

c. Appurtenant Structures.

(1) The principal spillway located at Station 1+00 is uncontrolled and consists of 24-inch diameter welded steel pipe with a hooded inlet which extends through the embankment at about Station 1+00. No signs of deterioration were noted at the inlet or outlet ends of the pipe. A beaver dam (mostly mud) obstructs the inlet of the spillway. Photo No. 6 show the inlet with the beaver dam. The outlet end of the pipe is shown in Photo No. 7. The reservoir level was at about invert elevation, but the entrance obstruction prevented flow through the pipe.

(2) The emergency spillway is uncontrolled and consists of an excavation through the left abutment. The spillway is well vegetated with grass. Several trees along the water line block the entrance to the spillway. Mr. Hall reported that the spillway has never operated. No erosion was observed in the spillway. The spillway outlets over the steep gully bank some 50 feet downstream from the centerline of the dam. Photos No. 8 and 9 show the emergency spillway.

(3) Drawdown Facilities. There are no drawdown facilities for this dam.

d. Reservoir Area. No significant erosion was evident around the shore line. Mr. Hall reported that the reservoir has silted in and that present capacity is probably not more than 1/3 of the original capacity of the reservoir. Photo 15 shows a portion of the reservoir.

e. Downstream Channel. The channel downstream from the principal spillway is overgrown with brush and trees. No significant erosion was noted in the downstream channel. Photo No. 5 shows the downstream channel.

3.2 EVALUATION

This dam appears to be in poor condition. The cause of the slump over the principal spillway pipe is not known. It could result from a leak in the pipe. No discharge was noted around the outlet end of the pipe; however, there was no flow in the pipe when inspected. The seepage and shear failure in the downstream slope pose serious threats to the integrity and safety of the structure under reservoir head pressures approaching the maximum impoundment level. Tree growth on the upstream and downstream slopes could ultimately add to the present impairment in structural integrity. Obstructions to spillway flow (trees in emergency spillway entrance and mud dam in front of principal spillway entrance) should be removed. Removal of trees should be done under the guidance of an engineer experienced in the design and construction of dams.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works for this dam. The pool level is controlled by rainfall, infiltration, evaporation, and the capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

There is no regular maintenance program for this dam as reflected by the slump over the principal spillway pipe, shear slides on the downstream slope, tree growth on the embankment slopes and emergency spillway entrance and obstruction of the principal spillway entrance.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

4.5 EVALUATION

Lack of maintenance and timely repair has resulted in the poor condition of the dam and if continued, will undoubtedly result in breaching of the dam.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data were found for this dam.

b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS Nemaha NE, MO 7 1/2 minute topographic quadrangle map. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection.

c. Visual Observations.

(1) The condition of the spillway is not known. A large slump is located over the pipe on the downstream slope (See Photo Nos. 10 and 11), and beavers have built a small mud dam around the entrance to the spillway (See Photo No. 6).

(2) The emergency spillway is located in the left abutment. Both the entrance and exit to the spillway are severely choked with small trees and shrubs. Spillway releases should not endanger the integrity of the dam.

(3) The old channel downstream of the dam is severely choked with trees, shrubs, and debris.

(4) No drawdown facilities are available to evacuate the pool.

d. Overtopping Potential. Based on approximate analyses, the spillways are too small to pass 50% of the probable maximum flood without overtopping. The spillways will not pass the one percent probability flood but will pass 14% of the PMF without overtopping. This dam could not withstand significant overtopping without serious damage.

The results of the routings through the dam are tabulated in regards to the following conditions:

Frequency	Inflow Discharge c.f.s.	Outflow Discharge c.f.s.	Maximum Pool Elevation	*Maximum Depth Over Dam Feet	Duration Over Top Hours
1%	740	450	989.7	0.5	1-
1/2 PMF	1470	1440	990.8	1.6	4+
PMF	2940	2880	991.8	2.6	6+
0.14 PMF	410	240	989.2	0	0

*Minimum Top of Dam Elevation - 989.2

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard rating and small size. Therefore, 1/2 PMF to the PMF is the test for the adequacy of the dam and its spillway.

The estimated damage zone is described in Paragraph 1.2d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation. This dam is or has been structurally unstable from the standpoint of shear strength and/or seepage pressures, as evidenced from the observed shear slide in the downstream section. It is also suspected that the slump or sink hole over the principal spillway pipe results from internal erosion caused by accelerated seepage along or from the pipe during periods of full flow in the pipe. It is quite possible that the cause(s) of the slump over the spillway pipe also caused or contributed to the shear failure on the downstream slope.

b. Design and Construction Data. No design or construction data were available. Seepage and stability analysis comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. There are no controlled operating facilities for this dam.

d. Post Construction Changes. The inspection team is not aware of any post construction changes except that the sink hole over the spillway pipe had been repaired once before.

e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of the magnitude predicted in this area would not ordinarily be expected to cause structural failure of this dam. However, it is possible that such seismic stresses could contribute to the failure of this dam in its present condition of questionable stability.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. This dam is considered to be structurally unstable from the standpoint of seepage pressure, shear strength and probably internal erosion along or around the spillway pipe. The approximate analyses performed for this report indicate that 0.5 of the Probable Maximum Flood would overtop the dam by 1.6 feet for a period of about 4 hours. Under present conditions, such overtopping would probably cause failure of the dam. Obstructions to the entrances of the spillways (trees and beaver dam) add to the apparent structural deficiencies of the dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

b. Adequacy of Information. Due to the lack of engineering data, the conclusions in this report are based upon performance history and visual observations. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. A program should be developed as soon as possible to monitor at regular intervals the deficiencies described in this report. The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Further Investigations. The additional studies and analyses recommended in paragraph 7.2b should be accomplished by the owner in the near future.

e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of the magnitude predicted for this area would not ordinarily be expected to cause structural failure of this dam. However, it is possible that such seismic activity could contribute to the failure of this dam in its present condition of questionable stability. It is recommended that the seismic loading for Zone 1 be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

a. Alternatives.

(1) The spillway size and/or the height of dam should be increased to pass 50 percent of the probable maximum flood without overtopping the dam.

b. Operation and Maintenance Procedures.

(1) In light of the owners report that the present reservoir capacity has been greatly reduced by siltation, it is recommended that additional studies be conducted to determine the potential downstream damage that might result from failure of this dam. These studies should include detailed topographic characteristics (stage-storage relationships) and water depths (present bottom elevations) of the reservoir area. A dam breach analyses should be conducted to determine the resultant downstream flood levels. This work should be done by a professional engineer experienced in the design and construction of dams.

(2) Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" should be performed. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) by a professional engineer experienced in the design and construction of dams.

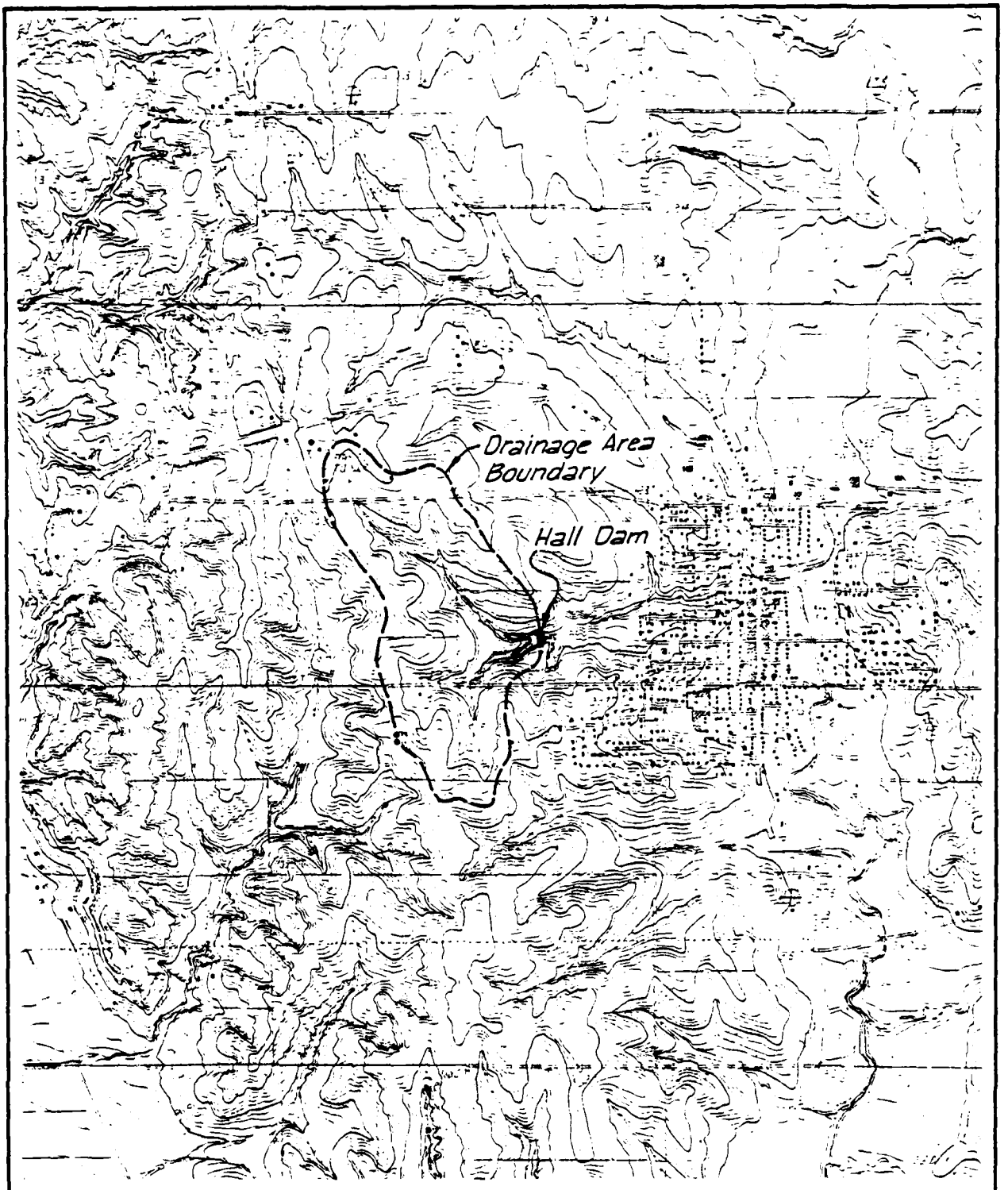
(3) The causes of the slump over the spillway pipe, the shear failures on the downstream slope, and the seepage through the embankment should be determined and the necessary repairs made. The investigations to determine the causes of these deficiencies and the engineering design needed in order to make the repairs should be performed by a professional engineer experienced in the design and construction of dams.

(4) The trees should be removed from the slopes of the dam and from the entrance of the emergency spillway. Measures should be taken to prevent recurrent growth. Trees in the exit channel of the emergency spillway and in the downstream channel are probably advantageous for erosion control and are not recommended for removal. Tree removal should be done under the guidance of a professional engineer experienced in the design and construction of dams.

(5) The beaver dam obstructing the principal spillway inlet should be removed. Measures should be taken to prevent reconstruction.

(6) A program of regular inspection and maintenance should be initiated for this dam.

APPENDIX A
MAPS



Scale in feet

2000 1000 0 2000 4000

Contour Interval – 10'

N

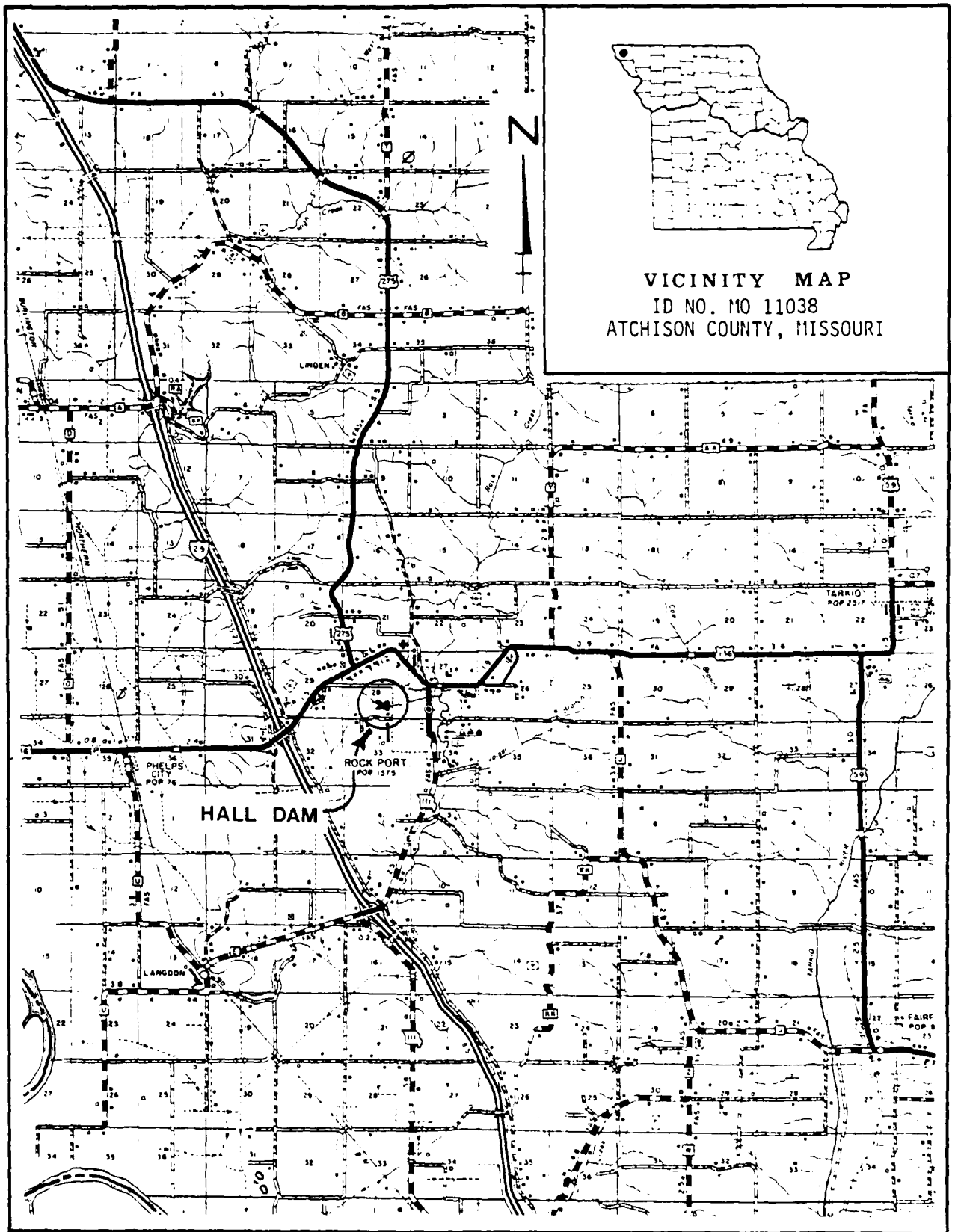
VICINITY TOPOGRAPHY

HALL DAM

ATCHISON COUNTY, MISSOURI

MO. 11038

PLATE A-1



LOCATION MAP

PLATE A-2

APPENDIX B
PHOTOGRAPHS

HALL DAM
ATCHINSON COUNTY, MISSOURI
MO 11038

PHOTO INDEX

PLATE B-1

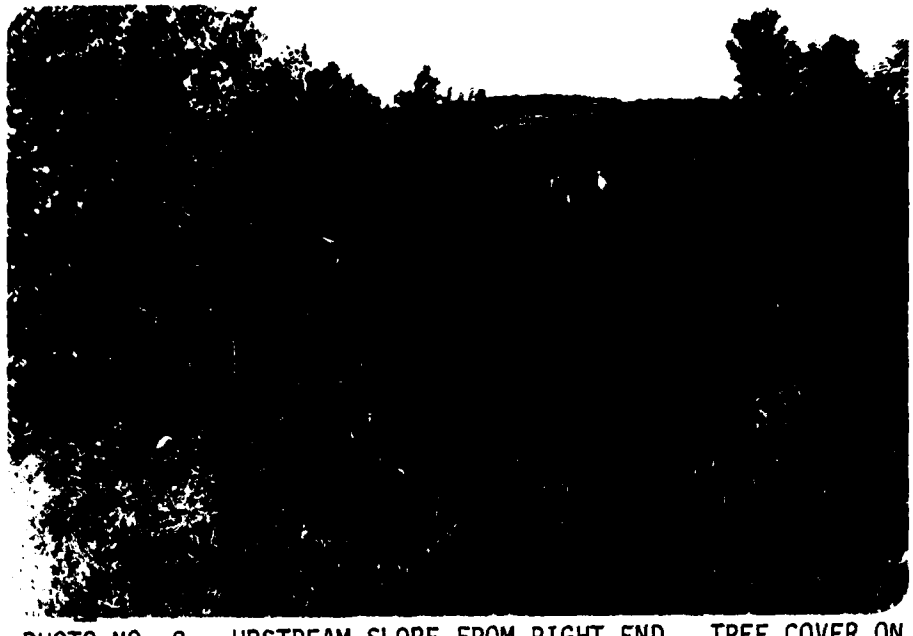


PHOTO NO. 2 - UPSTREAM SLOPE FROM RIGHT END. TREE COVER ON LEFT PREVENTS VIEW OF WATER EDGE.

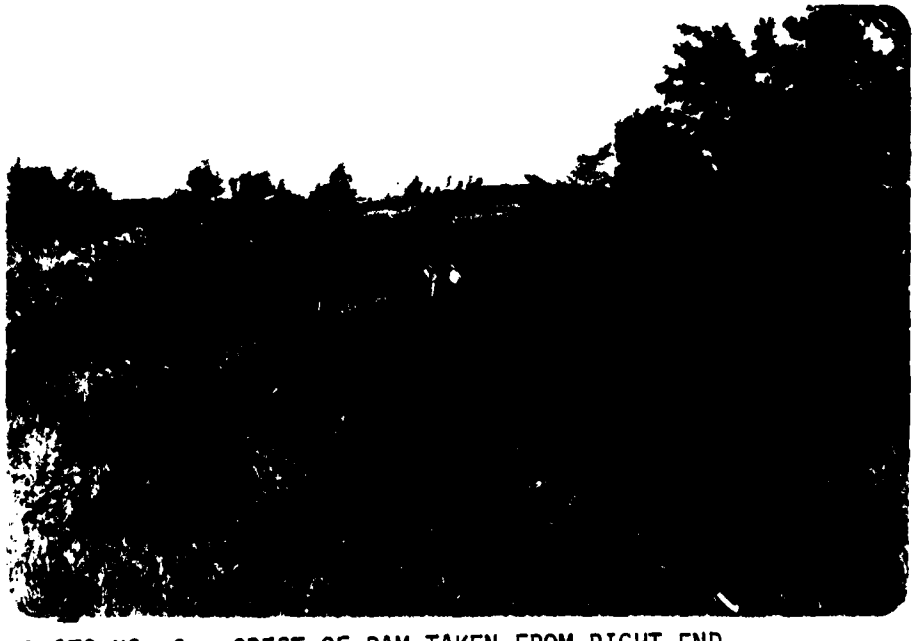


PHOTO NO. 3 - CREST OF DAM TAKEN FROM RIGHT END

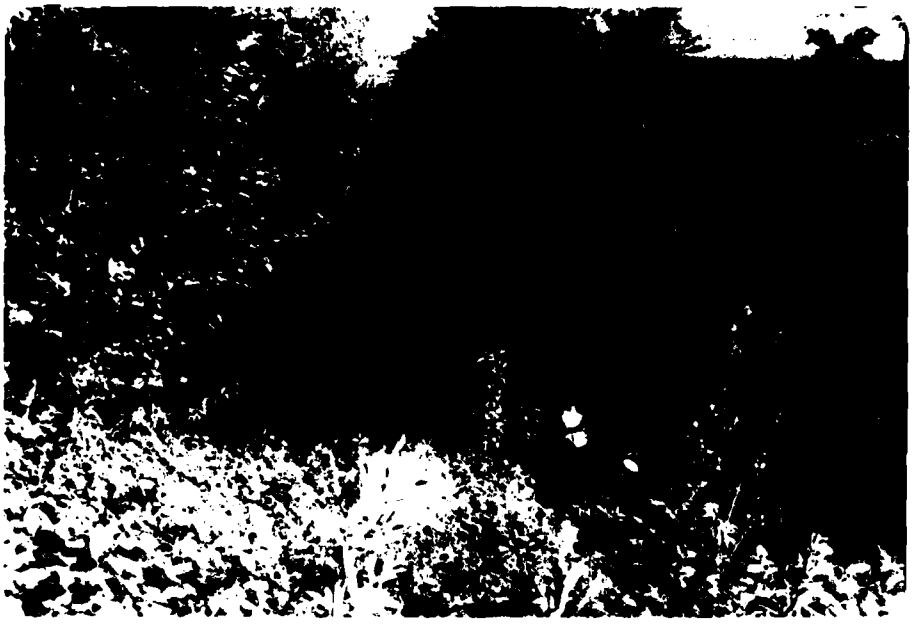


PHOTO NO. 4 - DOWNSTREAM SLOPE FROM RIGHT END.

PHOTO NO. 5 - VIEW DOWNSTREAM FROM STATION 1+25±. OLD CHANNEL IN CENTER OF PICTURE.

PHOTO NO. 6 - INLET END OF PIPE SPILLWAY SHOWING BEAVER DAM AT ENTRANCE.

PHOTO NO. 7 - OUTLET END OF PIPE SPILLWAY.

PHOTO NO. 8 - VIEW UPSTREAM IN EMERGENCY SPILLWAY. NOTE HEAVY TREE GROWTH.

PHOTO NO. 9 - VIEW DOWNSTREAM IN EMERGENCY SPILLWAY.

PHOTO NO. 10 - SLUMP AREA OVER PIPE SPILLWAY.

PHOTO NO. 11 - VIEW DOWNSTREAM OF SLUMP AREA OVER PIPE SPILLWAY.

PHOTO NO. 12 - SLUMP IN AREA OF SPILLWAY PIPE. STICK IN CENTER INDICATES UPPER LEVEL OF SEEPAGE OUTCROP.

PHOTO NO. 13 - VIEW OF SLUMP AREA TAKEN FROM RIGHT DOWNSTREAM ABUTMENT.

PHOTO NO. 14 - VIEW LOOKING UPSTREAM AT SLUMP AREA.

PHOTO NO. 15 - VIEW UPSTREAM TAKEN FROM STATION 1+40±.

PHOTO NO. 16 - VIEW LOOKING NORTH SHOWING DRAINAGEWAY DOWNSTREAM FROM DAM AT FIRST ROAD CROSSING.

PHOTO NO. 17 - VIEW DOWNSTREAM FROM ROAD SHOWN IN PHOTO NO. 17. ROAD SURFACE APPROXIMATELY 12' HIGHER THAN FLOW LINE OF CREEK.

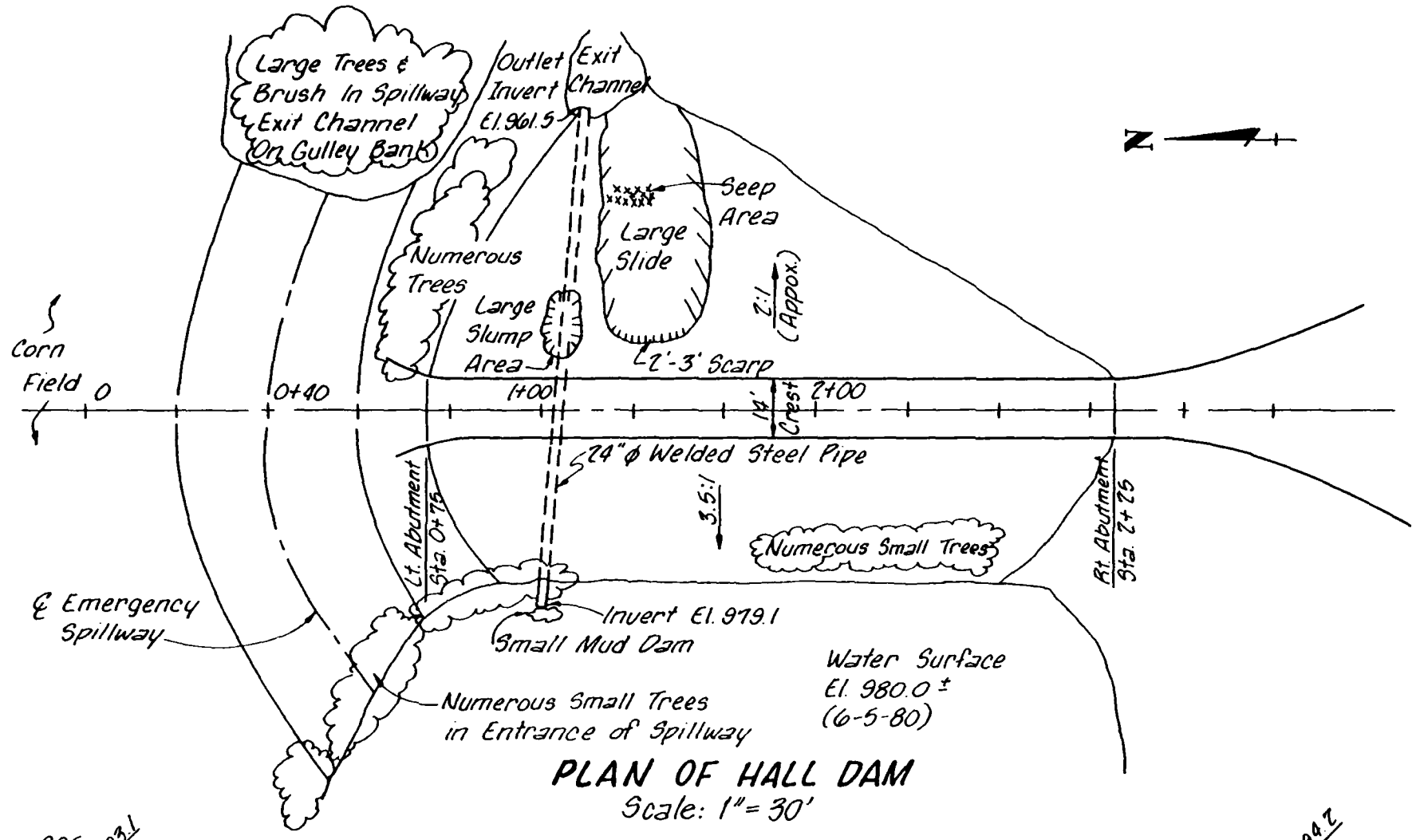
PHOTO NO. 18 - VIEW UPSTREAM IN CHANNEL. PHOTO TAKEN FROM NEBRASKA STREET LOOKING WEST.

PHOTO NO. 19 - VIEW DOWNSTREAM FROM NEBRASKA STREET LOOKING EAST. CHANNEL WIDTH - 50 TO 60'.

PHOTO NO. 20 - VIEW DOWNSTREAM FROM MARKET STREET SHOWING TWIN BOX CULVERT UNDER HIGHWAY 111.

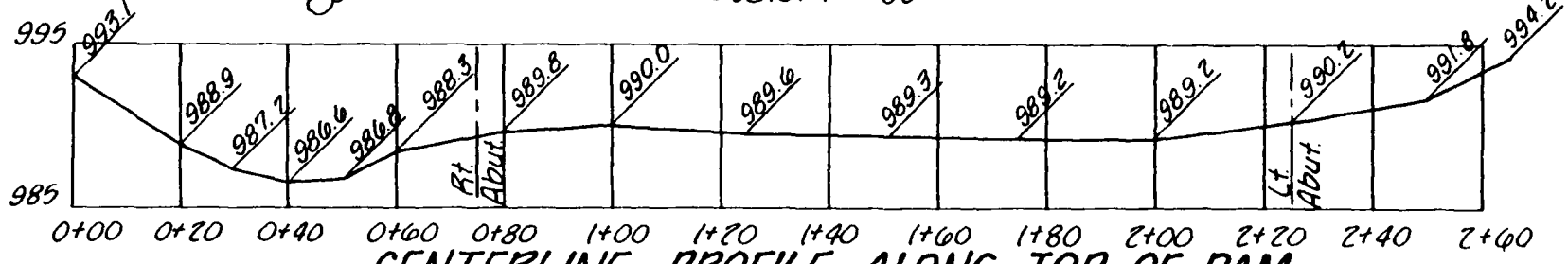
PHOTO NO. 21 - VIEW LOOKING EAST INTO BOX CULVERT CROSSING MARKET STREET.

APPENDIX C
PROJECT PLATES



PLAN OF HALL DAM

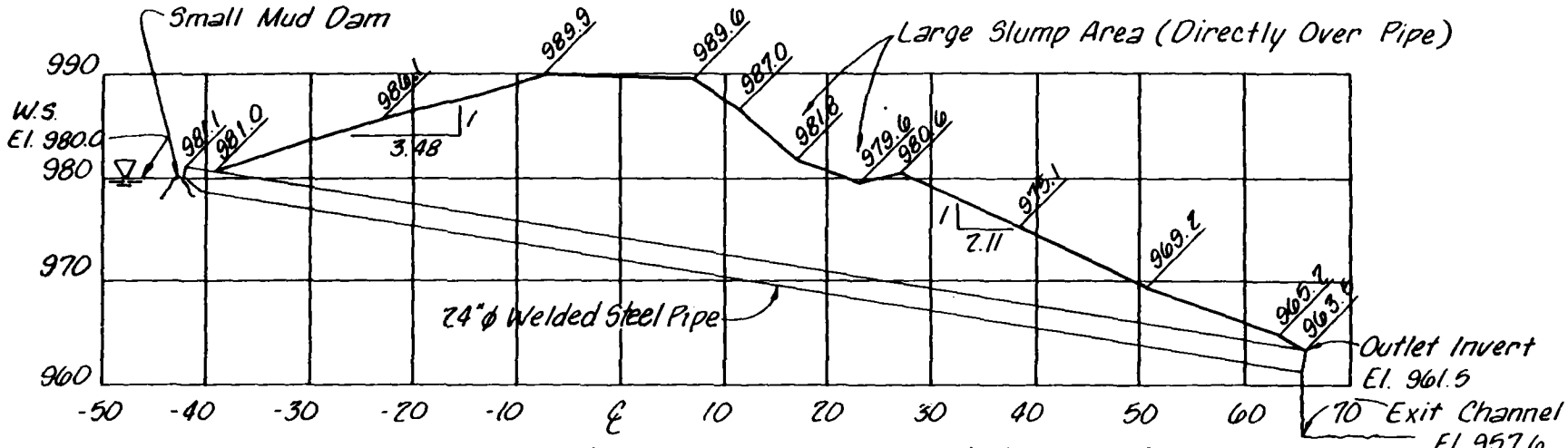
Scale: 1" = 30'



CENTERLINE PROFILE ALONG TOP OF DAM

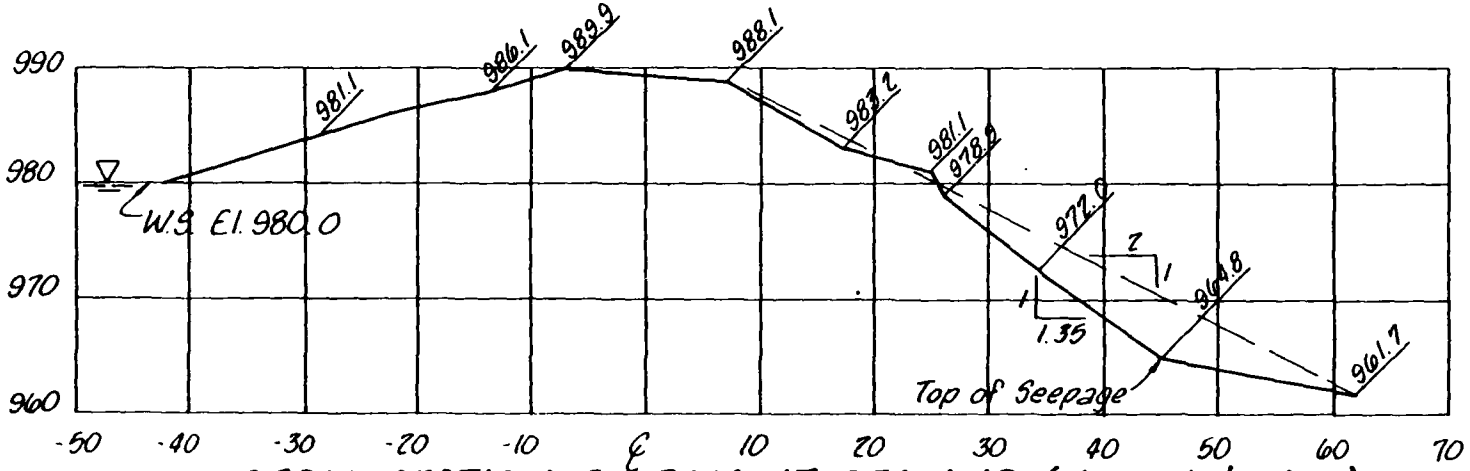
Scale: 1" = 30' Horiz.; 1" = 10' Vert.

PLATE C-1



MAXIMUM CROSS-SECTION OF DAM AT STA. 1+09

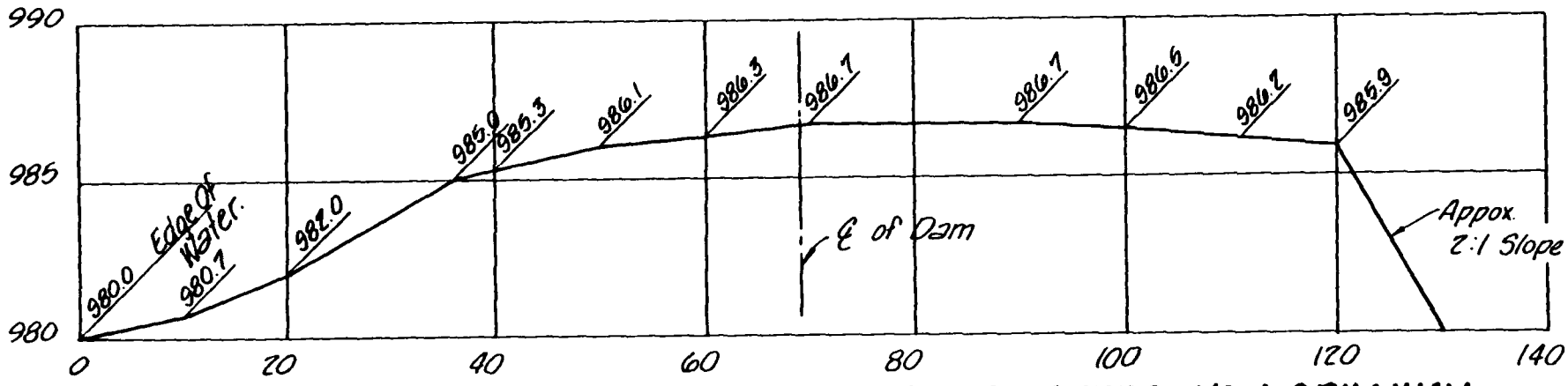
Scale: 1" = 15' H., 1" = 15' V.



CROSS-SECTION OF DAM AT STA. 1+17 (Thru Slide Area)

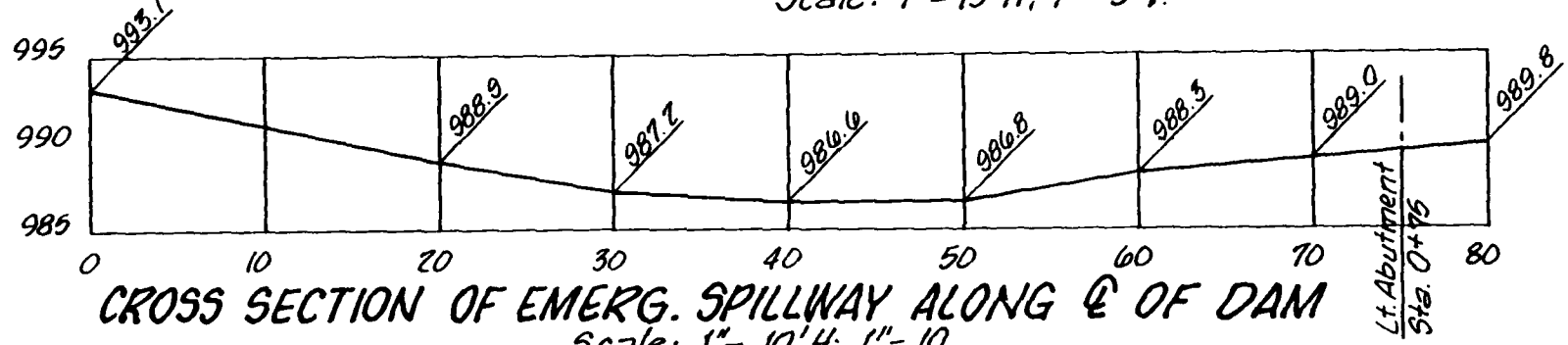
Scale: 1" = 15' H; 1" = 15' V.

PLATE C-2



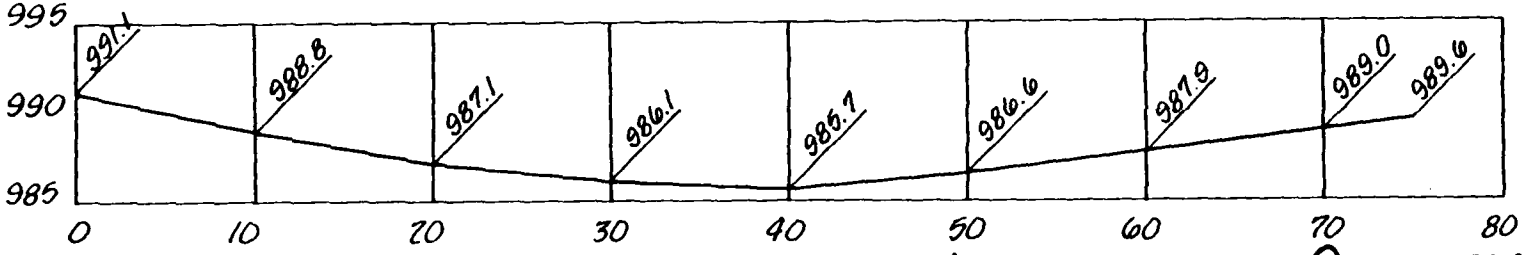
PROFILE ALONG CENTERLINE OF EMERGENCY SPILLWAY

Scale: 1" = 15' H; 1" = 5' V.



CROSS SECTION OF EMERG. SPILLWAY ALONG ℄ OF DAM

Scale: 1" = 10' H; 1" = 10



CROSS SECTION OF EMERG. SPILLWAY - 30' UPSTREAM OF ℄ OF DAM

Scale: 1" = 10' H; 1" = 10' V.

PLATE C-3

APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs (See this section).

   a. Twenty-four hours, ten percent probabilistic rainfall for the dam location was taken from the data for the rainfall station at Maryville, MO. as supplied by the St. Louis District, Corps of Engineers per their letter dated 4 March 1980. The twenty-four probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology.

   b. Drainage area = 0.295 square miles (189 acres)

   c. Time of concentration of runoff = 22.6 minutes (computed from the SCS "Upland" method).

   d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the ten percent probabilistic precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the invert of the principal spillway assuming that the antecedent storm would clear the small mud dam from the entrance.

   e. The total twenty-four hour storm duration losses for the ten percent probabilistic storm were 2.62 inches. The total losses for the PMF storm were 1.58 inches. These data are based on SCS runoff curve No. 88 and No. 74 for antecedent moisture conditions SCS AMC III and AMC II respectively. The watershed is composed of primarily SCS soil group B (Marshall and Knox soils) and consists of approximately 30% cultivated crops, 29% pasture, 24% timber, and 17% legumes or rotation meadow.

   f. Average soil loss rates = 0.06 inch per hour approximately. (for PMF storm, AMCIII)

2. The combined discharge rating consisted of three components: the flow through the principal spillway, the flow through the emergency spillway and the flow over the top of the dam.

   a. The principal spillway rating was developed using the Bureau of Public Roads "Hydraulic Engineering Circular No. 5, December 1965" assuming inlet control.

   b. The emergency spillway rating was developed using the Corps of Engineers Water Surface Profiles HEC-2 computer program. Critical depth was assumed to occur at approximately 48 feet downstream of the centerline of the dam.

   c. The flows over the dam were developed using the dam overtopping analysis (Flow over non-level dam crest) with the HEC-1 (Dam Safety Version) program.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The input, output, and plotted hydrographs are attached in this section.

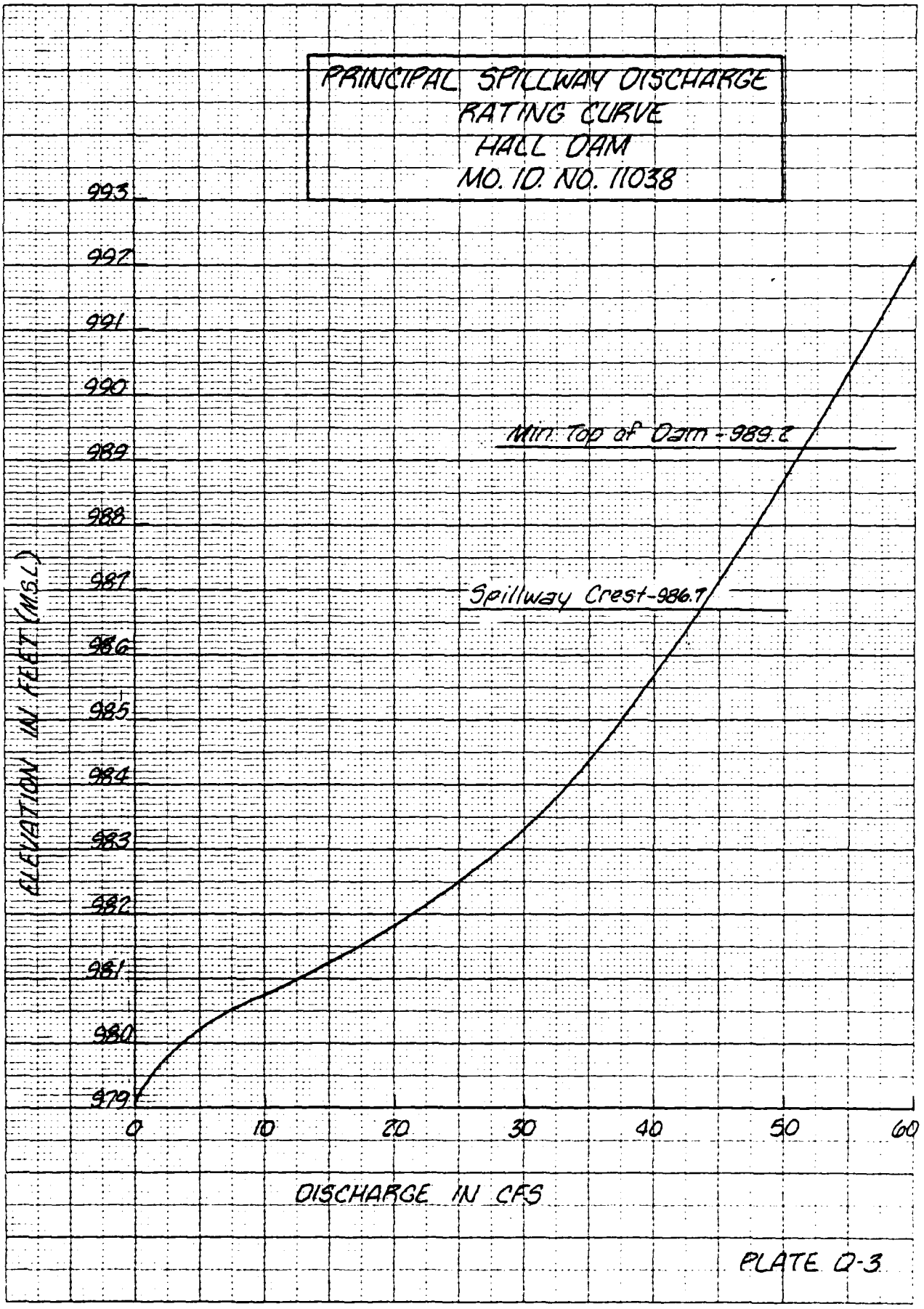


PLATE D-3

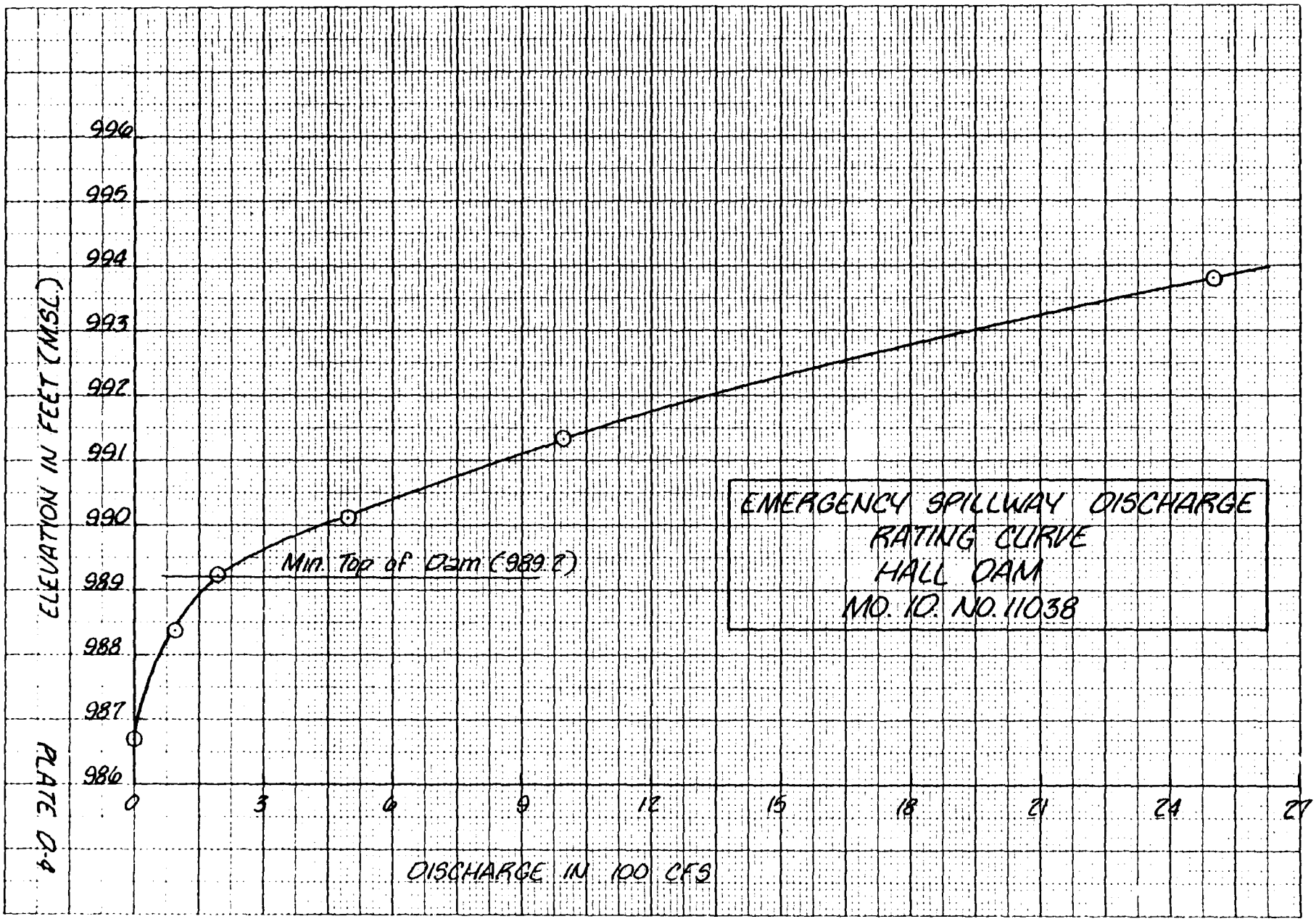


PLATE D-4

```
A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2       H & H ANALYSIS OF SAFETY OF EARL HALL DAM-MD 11038
A3       RATIOS OF PMF ROUTED THROUGH THE RESERVOIR
B 000288000000000000005                                  000000000000000000000003
B1000005
J 000001000000090000001
J10000.1000000.200000.2500000.3000000.35000000.400000.45000000.5000001.0
K 000000000001                          000000000000000000000001
K1       CALCULATION OF INFLOW HYDROGRAPH TO RES 11038
M 000001000000020000.295          0000.295000001.0                    00000001
P 000000000023.700000102000001210000130
T                                                                -1.0    -88.0
W2       0000.226
X 000000     -.0100000001
K 000001000000002                       000000020000000000000001
K1       ROUTED FLOWS THRU RESERVOIR 11038
Y                              000000010000000 1
Y1000001                                                  -979.1       -1
Y40979.000000980000009810000098200000983000009840000098500000986000986.700000987
Y40009880000098900098 9.500000990000990.500000991000009920000099300000994
Y500000000000003.500000013000000210000002800003 3.5000037.500000041000043.5000054.5
Y500011300000211000003020000048400000700000009070000139000001993000026 75
$A000000000001.4900003.7900007.81
$F000965000000980000009900000 1000
$$0979.1
$D0988.2000002.9000001.500000189
$L000025000000630000008700000107000001450000015500000162000001760000018300000189
$V0988.2000989.4000989.6000989.8000990.0000990.5000991.0000992.0000993.0000994.0
K 000099
A
A
A
A
A
```

PLATE D-5

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************

RUN  DATE= 80/06/11.
     TIME= 16.51.19.
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
H & H ANALYSIS OF SAFETY OF EARL HALL DAM-MO 11038
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR

JOB SPECIFICATION

NU	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
283	0	5	0	0	0	0	0	3	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1

RTIOS= .10 .20 .25 .30 .35 .40 .45 .50 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDROGRAPH TO RES 11038

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000001	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.30	0.00	.30	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.70	102.00	121.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRTR	DLTR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-88.00	0.00	0.00

CURVE NO = -88.00 WETNESS = -1.00 EFFECT CN = 88.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .23

RECESSION DATA
STRTQ= 0.00 QRCSN= -.01 RTIOR= 1.00

UNIT HYDROGRAPH 16 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .23 VOL= 1.00

108.	371.	529.	479.	326.	186.	114.	69.	41.	25.
15.	9.	6.	4.	2.	0.				

END-OF-PERIOD FLOW

PLATE D-6

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.05	145	.20	.19	.01	150.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	.20	.19	.01	200.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.15	147	.20	.19	.01	271.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.20	148	.20	.19	.01	335.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.25	149	.20	.19	.01	379.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.30	150	.20	.19	.01	405.
1.01	.35	7	.01	0.00	.01	0.	1.01	12.35	151	.20	.20	.01	421.
1.01	.40	8	.01	0.00	.01	0.	1.01	12.40	152	.20	.20	.01	431.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.20	.20	.01	437.
1.01	.50	10	.01	0.00	.01	0.	1.01	12.50	154	.20	.20	.01	441.
1.01	.55	11	.01	0.00	.01	0.	1.01	12.55	155	.20	.20	.01	444.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.00	156	.20	.20	.00	445.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.05	157	.24	.24	.01	451.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.10	158	.24	.24	.01	467.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.15	159	.24	.24	.01	488.
1.01	1.20	16	.01	0.00	.01	0.	1.01	13.20	160	.24	.24	.00	508.
1.01	1.25	17	.01	0.00	.01	0.	1.01	13.25	161	.24	.24	.00	521.
1.01	1.30	18	.01	0.00	.01	0.	1.01	13.30	162	.24	.24	.00	529.
1.01	1.35	19	.01	0.00	.01	0.	1.01	13.35	163	.24	.24	.00	534.
1.01	1.40	20	.01	0.00	.01	0.	1.01	13.40	164	.24	.24	.00	537.
1.01	1.45	21	.01	0.00	.01	0.	1.01	13.45	165	.24	.24	.00	540.
1.01	1.50	22	.01	0.00	.01	0.	1.01	13.50	166	.24	.24	.00	541.
1.01	1.55	23	.01	0.00	.01	0.	1.01	13.55	167	.24	.24	.00	542.
1.01	2.00	24	.01	.00	.01	0.	1.01	14.00	168	.24	.24	.00	543.
1.01	2.05	25	.01	.00	.01	0.	1.01	14.05	169	.30	.30	.00	550.
1.01	2.10	26	.01	.00	.01	0.	1.01	14.10	170	.30	.30	.00	573.
1.01	2.15	27	.01	.00	.01	0.	1.01	14.15	171	.30	.30	.00	605.
1.01	2.20	28	.01	.00	.01	1.	1.01	14.20	172	.30	.30	.00	634.
1.01	2.25	29	.01	.00	.01	1.	1.01	14.25	173	.30	.30	.00	653.
1.01	2.30	30	.01	.00	.01	2.	1.01	14.30	174	.30	.30	.00	665.
1.01	2.35	31	.01	.00	.01	2.	1.01	14.35	175	.30	.30	.00	672.
1.01	2.40	32	.01	.00	.01	2.	1.01	14.40	176	.30	.30	.00	676.
1.01	2.45	33	.01	.00	.01	3.	1.01	14.45	177	.30	.30	.00	679.
1.01	2.50	34	.01	.00	.01	3.	1.01	14.50	178	.30	.30	.00	681.
1.01	2.55	35	.01	.00	.01	4.	1.01	14.55	179	.30	.30	.00	682.
1.01	3.00	36	.01	.00	.01	4.	1.01	15.00	180	.30	.30	.00	683.
1.01	3.05	37	.01	.00	.01	4.	1.01	15.05	181	.18	.18	.00	671.
1.01	3.10	38	.01	.00	.01	5.	1.01	15.10	182	.37	.36	.00	647.
1.01	3.15	39	.01	.00	.01	5.	1.01	15.15	183	.37	.36	.00	653.
1.01	3.20	40	.01	.00	.01	5.	1.01	15.20	184	.55	.55	.00	713.
1.01	3.25	41	.01	.00	.01	6.	1.01	15.25	185	.64	.64	.00	840.
1.01	3.30	42	.01	.00	.01	6.	1.01	15.30	186	1.56	1.55	.01	1108.
1.01	3.35	43	.01	.00	.01	6.	1.01	15.35	187	2.57	2.56	.01	1713.
1.01	3.40	44	.01	.00	.01	7.	1.01	15.40	188	1.01	1.01	.00	2518.
1.01	3.45	45	.01	.00	.01	7.	1.01	15.45	189	.64	.64	.00	2944.
1.01	3.50	46	.01	.00	.01	7.	1.01	15.50	190	.55	.55	.00	2799.
1.01	3.55	47	.01	.00	.01	7.	1.01	15.55	191	.37	.37	.00	2382.
1.01	4.00	48	.01	.00	.01	8.	1.01	16.00	192	.37	.37	.00	1841.
1.01	4.05	49	.01	.00	.01	8.	1.01	16.05	193	.28	.28	.00	1470.
1.01	4.10	50	.01	.00	.01	8.	1.01	16.10	194	.28	.28	.00	1187.
1.01	4.15	51	.01	.00	.01	9.	1.01	16.15	195	.28	.28	.00	984.
1.01	4.20	52	.01	.00	.01	9.	1.01	16.20	196	.28	.28	.00	851.
1.01	4.25	53	.01	.00	.01	9.	1.01	16.25	197	.28	.28	.00	767.
1.01	4.30	54	.01	.00	.01	9.	1.01	16.30	198	.28	.28	.00	713.
1.01	4.35	55	.01	.00	.01	10.	1.01	16.35	199	.28	.28	.00	680.
1.01	4.40	56	.01	.00	.01	10.	1.01	16.40	200	.28	.28	.00	669.
1.01	4.45	57	.01	.00	.01	10.	1.01	16.45	201	.28	.28	.00	657.
1.01	4.50	58	.01	.00	.01	10.	1.01	16.50	202	.28	.28	.00	649.
1.01	4.55	59	.01	.00	.01	11.	1.01	16.55	203	.28	.28	.00	645.
1.01	5.00	60	.01	.01	.01	11.	1.01	17.00	204	.28	.28	.00	644.

PLATE D-7

1.01	5.05	61	.01	.01	.01	11.	1.01	17.05	205	.22	.22	.00	636.
1.01	5.10	62	.01	.01	.01	11.	1.01	17.10	206	.22	.22	.00	614.
1.01	5.15	63	.01	.01	.01	11.	1.01	17.15	207	.22	.22	.00	592.
1.01	5.20	64	.01	.01	.01	12.	1.01	17.20	208	.22	.22	.00	573.
1.01	5.25	65	.01	.01	.01	12.	1.01	17.25	209	.22	.22	.00	553.
1.01	5.30	66	.01	.01	.01	12.	1.01	17.30	210	.22	.22	.00	537.
1.01	5.35	67	.01	.01	.01	12.	1.01	17.35	211	.22	.22	.00	515.
1.01	5.40	68	.01	.01	.01	12.	1.01	17.40	212	.22	.22	.00	511.
1.01	5.45	69	.01	.01	.01	13.	1.01	17.45	213	.22	.22	.00	503.
1.01	5.50	70	.01	.01	.01	13.	1.01	17.50	214	.22	.22	.00	507.
1.01	5.55	71	.01	.01	.01	13.	1.01	17.55	215	.22	.22	.00	506.
1.01	6.00	72	.01	.01	.01	13.	1.01	18.00	216	.22	.22	.00	504.
1.01	6.05	73	.06	.03	.03	16.	1.01	18.05	217	.02	.02	.00	433.
1.01	6.10	74	.06	.03	.03	26.	1.01	18.10	218	.02	.02	.00	408.
1.01	6.15	75	.06	.04	.03	42.	1.01	18.15	219	.02	.02	.00	300.
1.01	6.20	76	.06	.04	.02	56.	1.01	18.20	220	.02	.02	.00	202.
1.01	6.25	77	.06	.04	.02	67.	1.01	18.25	221	.02	.02	.00	136.
1.01	6.30	78	.06	.04	.02	75.	1.01	18.30	222	.02	.02	.00	98.
1.01	6.35	79	.06	.04	.02	81.	1.01	18.35	223	.02	.02	.00	75.
1.01	6.40	80	.06	.04	.02	86.	1.01	18.40	224	.02	.02	.00	61.
1.01	6.45	81	.06	.04	.02	90.	1.01	18.45	225	.02	.02	.00	53.
1.01	6.50	82	.06	.04	.02	93.	1.01	18.50	226	.02	.02	.00	48.
1.01	6.55	83	.06	.05	.02	96.	1.01	18.55	227	.02	.02	.00	45.
1.01	7.00	84	.06	.05	.02	98.	1.01	19.00	228	.02	.02	.00	43.
1.01	7.05	85	.06	.05	.02	101.	1.01	19.05	229	.02	.02	.00	42.
1.01	7.10	86	.06	.05	.01	103.	1.01	19.10	230	.02	.02	.00	41.
1.01	7.15	87	.06	.05	.01	105.	1.01	19.15	231	.02	.02	.00	41.
1.01	7.20	88	.06	.05	.01	107.	1.01	19.20	232	.02	.02	.00	41.
1.01	7.25	89	.06	.05	.01	108.	1.01	19.25	233	.02	.02	.00	41.
1.01	7.30	90	.06	.05	.01	110.	1.01	19.30	234	.02	.02	.00	41.
1.01	7.35	91	.06	.05	.01	111.	1.01	19.35	235	.02	.02	.00	41.
1.01	7.40	92	.06	.05	.01	112.	1.01	19.40	236	.02	.02	.00	41.
1.01	7.45	93	.06	.05	.01	114.	1.01	19.45	237	.02	.02	.00	41.
1.01	7.50	94	.06	.05	.01	115.	1.01	19.50	238	.02	.02	.00	41.
1.01	7.55	95	.06	.05	.01	116.	1.01	19.55	239	.02	.02	.00	41.
1.01	8.00	96	.06	.05	.01	117.	1.01	20.00	240	.02	.02	.00	41.
1.01	8.05	97	.06	.05	.01	118.	1.01	20.05	241	.02	.02	.00	41.
1.01	8.10	98	.06	.05	.01	119.	1.01	20.10	242	.02	.02	.00	41.
1.01	8.15	99	.06	.05	.01	120.	1.01	20.15	243	.02	.02	.00	41.
1.01	8.20	100	.06	.05	.01	121.	1.01	20.20	244	.02	.02	.00	41.
1.01	8.25	101	.06	.05	.01	121.	1.01	20.25	245	.02	.02	.00	41.
1.01	8.30	102	.06	.05	.01	122.	1.01	20.30	246	.02	.02	.00	41.
1.01	8.35	103	.06	.05	.01	123.	1.01	20.35	247	.02	.02	.00	41.
1.01	8.40	104	.06	.05	.01	123.	1.01	20.40	248	.02	.02	.00	41.
1.01	8.45	105	.06	.06	.01	124.	1.01	20.45	249	.02	.02	.00	41.
1.01	8.50	106	.06	.06	.01	125.	1.01	20.50	250	.02	.02	.00	41.
1.01	8.55	107	.06	.06	.01	125.	1.01	20.55	251	.02	.02	.00	41.
1.01	9.00	108	.06	.06	.01	126.	1.01	21.00	252	.02	.02	.00	41.
1.01	9.05	109	.06	.06	.01	126.	1.01	21.05	253	.02	.02	.00	41.
1.01	9.10	110	.06	.06	.01	127.	1.01	21.10	254	.02	.02	.00	41.
1.01	9.15	111	.06	.06	.01	127.	1.01	21.15	255	.02	.02	.00	41.
1.01	9.20	112	.06	.06	.01	128.	1.01	21.20	256	.02	.02	.00	41.
1.01	9.25	113	.06	.06	.01	128.	1.01	21.25	257	.02	.02	.00	41.
1.01	9.30	114	.06	.06	.01	129.	1.01	21.30	258	.02	.02	.00	41.
1.01	9.35	115	.06	.06	.01	129.	1.01	21.35	259	.02	.02	.00	41.
1.01	9.40	116	.06	.06	.01	129.	1.01	21.40	260	.02	.02	.00	41.
1.01	9.45	117	.06	.06	.01	130.	1.01	21.45	261	.02	.02	.00	41.
1.01	9.50	118	.06	.06	.01	130.	1.01	21.50	262	.02	.02	.00	41.
1.01	9.55	119	.06	.06	.00	131.	1.01	21.55	263	.02	.02	.00	41.
1.01	10.00	120	.06	.06	.00	131.	1.01	22.00	264	.02	.02	.00	41.
1.01	10.05	121	.06	.06	.00	131.	1.01	22.05	265	.02	.02	.00	41.
1.01	10.10	122	.06	.06	.00	131.	1.01	22.10	266	.02	.02	.00	41.

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1.01	10.15	123	.06	.06	.00	132.	1.01	22.15	267	.02	.02	.00	41.
1.01	10.20	124	.06	.06	.00	132.	1.01	22.20	268	.02	.02	.00	41.
1.01	10.25	125	.06	.06	.00	132.	1.01	22.25	269	.02	.02	.00	41.
1.01	10.30	126	.06	.06	.00	133.	1.01	22.30	270	.02	.02	.00	41.
1.01	10.35	127	.06	.06	.00	133.	1.01	22.35	271	.02	.02	.00	41.
1.01	10.40	128	.06	.06	.00	133.	1.01	22.40	272	.02	.02	.00	41.
1.01	10.45	129	.06	.06	.00	133.	1.01	22.45	273	.02	.02	.00	41.
1.01	10.50	130	.06	.06	.00	133.	1.01	22.50	274	.02	.02	.00	41.
1.01	10.55	131	.06	.06	.00	134.	1.01	22.55	275	.02	.02	.00	41.
1.01	11.00	132	.06	.06	.00	134.	1.01	23.00	276	.02	.02	.00	41.
1.01	11.05	133	.06	.06	.00	134.	1.01	23.05	277	.02	.02	.00	41.
1.01	11.10	134	.06	.06	.00	134.	1.01	23.10	278	.02	.02	.00	41.
1.01	11.15	135	.06	.06	.00	134.	1.01	23.15	279	.02	.02	.00	41.
1.01	11.20	136	.06	.06	.00	135.	1.01	23.20	280	.02	.02	.00	41.
1.01	11.25	137	.06	.06	.00	135.	1.01	23.25	281	.02	.02	.00	41.
1.01	11.30	138	.06	.06	.00	135.	1.01	23.30	282	.02	.02	.00	41.
1.01	11.35	139	.06	.06	.00	135.	1.01	23.35	283	.02	.02	.00	41.
1.01	11.40	140	.06	.06	.00	135.	1.01	23.40	284	.02	.02	.00	41.
1.01	11.45	141	.06	.06	.00	135.	1.01	23.45	285	.02	.02	.00	41.
1.01	11.50	142	.06	.06	.00	136.	1.01	23.50	286	.02	.02	.00	41.
1.01	11.55	143	.06	.06	.00	136.	1.01	23.55	287	.02	.02	.00	41.
1.01	12.00	144	.06	.06	.00	136.	1.02	0.00	288	.02	.02	.00	41.
									SUM	30.81	29.23	1.58	66648.
										(783.)	(742.)	(40.)	(1887.26)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2944.	751.	231.	231.	66597.
CMS	83.	21.	7.	7.	1886.
INCHES		23.68	29.17	29.17	29.17
MM		601.46	740.84	740.84	740.84
AC-FT		372.	459.	459.	459.
THOUS CU M		459.	566.	566.	566.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	294.	75.	23.	23.	6660.
CMS	8.	2.	1.	1.	189.
INCHES		2.37	2.92	2.92	2.92
MM		60.15	74.08	74.08	74.08
AC-FT		37.	46.	46.	46.
THOUS CU M		46.	57.	57.	57.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	589.	150.	46.	46.	13319.
CMS	17.	4.	1.	1.	377.
INCHES		4.74	5.83	5.83	5.83
MM		120.29	148.17	148.17	148.17
AC-FT		74.	92.	92.	92.
THOUS CU M		92.	113.	113.	113.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 3

CMS	42.	11.	3.	3.	943.
INCHES		11.84	14.58	14.58	14.58
MM		300.73	370.42	370.42	370.42
AC-FT		186.	229.	229.	229.
THOUS CU M		230.	283.	283.	283.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 9

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2944.	751.	231.	231.	66597.
CMS	83.	21.	7.	7.	1886.
INCHES		23.68	29.17	29.17	29.17
MM		601.46	740.84	740.84	740.84
AC-FT		372.	459.	459.	459.
THOUS CU M		459.	566.	566.	566.

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HYDROGRAPH ROUTING

ROUTED FLOWS THRU RESERVOIR 11038

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000002	1	0	0	2	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-979.	-1

STAGE	979.00	980.00	981.00	982.00	983.00	984.00	985.00	986.00	986.70	987.00
	988.00	989.00	989.50	990.00	990.50	991.00	992.00	993.00	994.00	
FLOW	0.00	3.50	13.00	21.00	28.00	33.50	37.50	41.00	43.50	54.50
	113.00	211.00	302.00	484.00	700.00	907.00	1390.00	1993.00	2675.00	
SURFACE AREA=	0.	1.	4.	8.						
CAPACITY=	0.	7.	33.	90.						
ELEVATION=	965.	980.	990.	1000.						

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
979.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
989.2	2.9	1.5	189.

CREST LENGTH AT OR BELOW	25.	63.	87.	107.	145.	155.	162.	176.	183.	189.
ELEVATION	989.2	989.4	989.6	989.8	990.0	990.5	991.0	992.0	993.0	994.0

STATION 000002, PLAN 1, RATIO 1

PLATE D-10

DVN

STATION 000002, PLAN 1, RATIO = 0.50 PMF

END-OF PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	2.	2.
2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
2.	2.	2.	3.	3.	3.	4.	5.	7.	8.
10.	11.	12.	14.	15.	16.	17.	18.	19.	20.
21.	22.	23.	24.	25.	25.	26.	27.	28.	28.
29.	30.	30.	31.	31.	32.	32.	33.	33.	34.
34.	34.	35.	35.	35.	36.	36.	36.	37.	37.
37.	38.	38.	38.	38.	39.	39.	39.	39.	40.
40.	40.	40.	41.	41.	41.	41.	42.	42.	42.
42.	42.	43.	43.	43.	44.	50.	60.	75.	89.
103.	118.	137.	152.	164.	175.	184.	192.	200.	209.
222.	234.	244.	251.	257.	261.	264.	267.	269.	273.
281.	293.	305.	316.	325.	332.	337.	339.	340.	341.
339.	333.	328.	337.	372.	454.	652.	1029.	1360.	1436.
1283.	1048.	839.	679.	566.	483.	425.	387.	362.	347.
337.	330.	326.	324.	322.	318.	309.	298.	287.	278.
271.	266.	262.	259.	257.	256.	253.	244.	224.	201.
180.	158.	137.	118.	106.	96.	87.	79.	72.	66.
60.	55.	52.	49.	47.	45.	43.	43.	43.	43.
43.	42.	42.	42.	42.	42.	42.	41.	41.	41.
41.	41.	40.	40.	40.	40.	40.	40.	39.	39.
39.	39.	39.	39.	38.	38.	38.	38.	38.	37.
37.	37.	37.	37.	37.	36.	36.	36.	36.	36.
35.	35.	35.	35.	35.	35.	34.	34.		

STORAGE

6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	8.	8.	8.	8.
8.	9.	9.	9.	9.	10.	10.	10.	10.	11.
11.	11.	11.	12.	12.	12.	12.	12.	13.	13.
13.	13.	14.	14.	14.	14.	14.	15.	15.	15.
15.	15.	16.	16.	16.	16.	16.	17.	17.	17.
17.	17.	18.	18.	18.	18.	18.	19.	19.	19.
19.	19.	19.	20.	20.	20.	20.	20.	21.	21.
21.	21.	21.	21.	22.	22.	22.	23.	24.	25.
25.	26.	27.	27.	28.	28.	28.	29.	29.	29.
30.	30.	30.	30.	30.	30.	30.	30.	30.	30.
31.	31.	31.	31.	31.	31.	31.	31.	31.	31.
31.	31.	31.	31.	31.	32.	33.	34.	36.	34.
35.	35.	34.	33.	33.	32.	32.	32.	31.	31.
31.	31.	31.	31.	31.	31.	31.	31.	31.	31.
30.	30.	30.	30.	30.	30.	30.	30.	30.	29.
28.	27.	27.	26.	26.	25.	25.	24.	24.	23.
23.	23.	23.	22.	22.	22.	22.	22.	22.	21.

21.	21.	21.	21.	21.	21.	20.	20.	20.	20.
20.	20.	20.	19.	19.	19.	19.	19.	19.	19.
18.	18.	18.	18.	18.	18.	18.	18.	17.	17.
17.	17.	17.	17.	17.	17.	17.	16.	16.	16.
16.	16.	16.	16.	16.	16.	15.	15.		

STAGE

979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1
979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1
979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1
979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1
979.2	979.2	979.2	979.2	979.2	979.2	979.2	979.2	979.3	979.3
979.3	979.3	979.3	979.3	979.4	979.4	979.4	979.4	979.4	979.5
979.5	979.5	979.5	979.5	979.6	979.6	979.6	979.6	979.6	979.6
979.7	979.7	979.7	979.8	979.8	979.9	980.0	980.2	980.3	980.5
980.6	980.8	980.9	981.1	981.2	981.4	981.5	981.6	981.8	981.9
982.0	982.2	982.3	982.4	982.5	982.6	982.7	982.9	983.0	983.1
983.2	983.3	983.4	983.5	983.6	983.7	983.8	983.9	984.0	984.0
984.1	984.2	984.3	984.4	984.5	984.6	984.6	984.7	984.8	984.9
985.0	985.0	985.1	985.2	985.3	985.3	985.4	985.5	985.6	985.6
985.7	985.8	985.8	985.9	986.0	986.0	986.1	986.2	986.2	986.3
986.3	986.4	986.5	986.5	986.6	986.7	986.9	987.1	987.3	987.6
987.8	988.1	988.2	988.4	988.5	988.6	988.7	988.8	988.9	989.0
989.1	989.1	989.2	989.2	989.2	989.3	989.3	989.3	989.3	989.3
989.4	989.4	989.4	989.5	989.5	989.5	989.5	989.5	989.5	989.5
989.5	989.5	989.5	989.5	989.6	989.7	990.0	990.4	990.7	990.8
990.6	990.4	990.2	990.0	989.9	989.8	989.7	989.6	989.6	989.5
989.5	989.5	989.5	989.5	989.5	989.5	989.4	989.4	989.4	989.3
989.3	989.3	989.3	989.3	989.3	989.2	989.2	989.2	989.1	988.9
988.7	988.5	988.2	988.1	987.9	987.7	987.6	987.4	987.3	987.2
987.1	987.0	986.9	986.9	986.8	986.7	986.7	986.6	986.6	986.5
986.5	986.4	986.4	986.3	986.3	986.2	986.1	986.1	986.0	986.0
985.9	985.9	985.8	985.8	985.7	985.7	985.6	985.6	985.5	985.5
985.4	985.4	985.3	985.3	985.2	985.2	985.1	985.1	985.0	985.0
985.0	984.9	984.9	984.8	984.8	984.7	984.7	984.6	984.6	984.5
984.5	984.5	984.4	984.4	984.3	984.3	984.2	984.2		

PEAK OUTFLOW IS 1436. AT TIME 15.83 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1436.	367.	111.	111.	31954.
CMS	41.	10.	3.	3.	905.
INCHES		11.58	14.00	14.00	14.00
MM		294.11	355.58	355.58	355.58
AC-FT		182.	220.	220.	220.
THOUS CU M		225.	272.	272.	272.

PLATE D-11

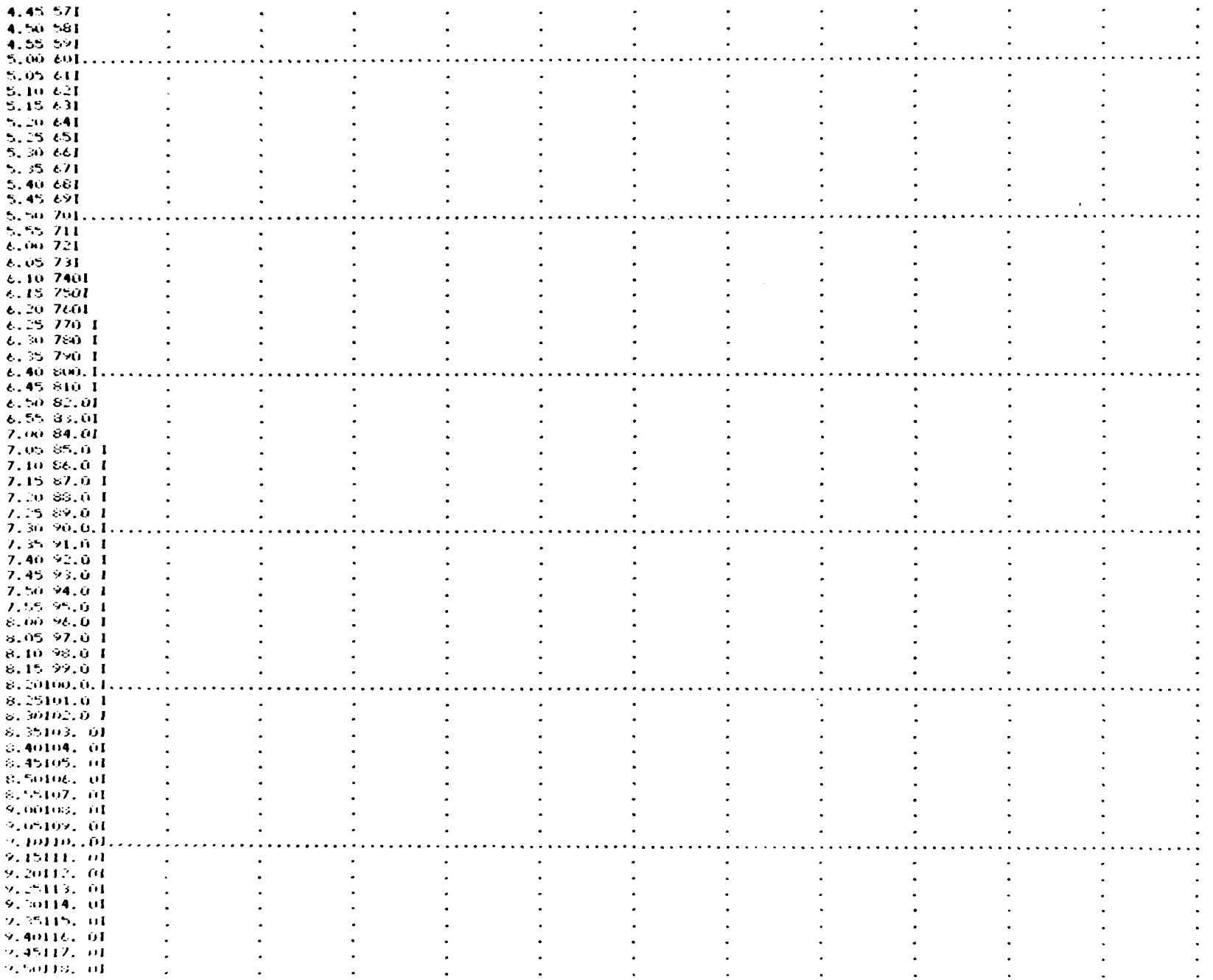
OVF

STATION000002

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

	0.	200.	400.	600.	800.	1000.	1200.	1400.	1600.	0.	0.	0.	0.
.05	1I	.	.	.	.	.	.	.	.	.	.	.	.
.10	2I	.	.	.	.	.	.	.	.	.	.	.	.
.15	3I	.	.	.	.	.	.	.	.	.	.	.	.
.20	4I	.	.	.	.	.	.	.	.	.	.	.	.
.25	5I	.	.	.	.	.	.	.	.	.	.	.	.
.30	6I	.	.	.	.	.	.	.	.	.	.	.	.
.35	7I	.	.	.	.	.	.	.	.	.	.	.	.
.40	8I	.	.	.	.	.	.	.	.	.	.	.	.
.45	9I	.	.	.	.	.	.	.	.	.	.	.	.
.50	10I	.	.	.	.	.	.	.	.	.	.	.	.
.55	11I	.	.	.	.	.	.	.	.	.	.	.	.
1.00	12I	.	.	.	.	.	.	.	.	.	.	.	.
1.05	13I	.	.	.	.	.	.	.	.	.	.	.	.
1.10	14I	.	.	.	.	.	.	.	.	.	.	.	.
1.15	15I	.	.	.	.	.	.	.	.	.	.	.	.
1.20	16I	.	.	.	.	.	.	.	.	.	.	.	.
1.25	17I	.	.	.	.	.	.	.	.	.	.	.	.
1.30	18I	.	.	.	.	.	.	.	.	.	.	.	.
1.35	19I	.	.	.	.	.	.	.	.	.	.	.	.
1.40	20I	.	.	.	.	.	.	.	.	.	.	.	.
1.45	21I	.	.	.	.	.	.	.	.	.	.	.	.
1.50	22I	.	.	.	.	.	.	.	.	.	.	.	.
1.55	23I	.	.	.	.	.	.	.	.	.	.	.	.
2.00	24I	.	.	.	.	.	.	.	.	.	.	.	.
2.05	25I	.	.	.	.	.	.	.	.	.	.	.	.
2.10	26I	.	.	.	.	.	.	.	.	.	.	.	.
2.15	27I	.	.	.	.	.	.	.	.	.	.	.	.
2.20	28I	.	.	.	.	.	.	.	.	.	.	.	.
2.25	29I	.	.	.	.	.	.	.	.	.	.	.	.
2.30	30I	.	.	.	.	.	.	.	.	.	.	.	.
2.35	31I	.	.	.	.	.	.	.	.	.	.	.	.
2.40	32I	.	.	.	.	.	.	.	.	.	.	.	.
2.45	33I	.	.	.	.	.	.	.	.	.	.	.	.
2.50	34I	.	.	.	.	.	.	.	.	.	.	.	.
2.55	35I	.	.	.	.	.	.	.	.	.	.	.	.
3.00	36I	.	.	.	.	.	.	.	.	.	.	.	.
3.05	37I	.	.	.	.	.	.	.	.	.	.	.	.
3.10	38I	.	.	.	.	.	.	.	.	.	.	.	.
3.15	39I	.	.	.	.	.	.	.	.	.	.	.	.
3.20	40I	.	.	.	.	.	.	.	.	.	.	.	.
3.25	41I	.	.	.	.	.	.	.	.	.	.	.	.
3.30	42I	.	.	.	.	.	.	.	.	.	.	.	.
3.35	43I	.	.	.	.	.	.	.	.	.	.	.	.
3.40	44I	.	.	.	.	.	.	.	.	.	.	.	.
3.45	45I	.	.	.	.	.	.	.	.	.	.	.	.
3.50	46I	.	.	.	.	.	.	.	.	.	.	.	.
3.55	47I	.	.	.	.	.	.	.	.	.	.	.	.
4.00	48I	.	.	.	.	.	.	.	.	.	.	.	.
4.05	49I	.	.	.	.	.	.	.	.	.	.	.	.
4.10	50I	.	.	.	.	.	.	.	.	.	.	.	.
4.15	51I	.	.	.	.	.	.	.	.	.	.	.	.
4.20	52I	.	.	.	.	.	.	.	.	.	.	.	.
4.25	53I	.	.	.	.	.	.	.	.	.	.	.	.
4.30	54I	.	.	.	.	.	.	.	.	.	.	.	.
4.35	55I	.	.	.	.	.	.	.	.	.	.	.	.
4.40	56I	.	.	.	.	.	.	.	.	.	.	.	.

PLATE D-12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4.50 58I
4.55 59I
5.00 60I
5.05 61I
5.10 62I
5.15 63I
5.20 64I
5.25 65I
5.30 66I
5.35 67I
5.40 68I
5.45 69I
5.50 70I
5.55 71I
6.00 72I
6.05 73I
6.10 74OI
6.15 75OI
6.20 76OI
6.25 770 I
6.30 780 I
6.35 790 I
6.40 800.I
6.45 810 I
6.50 82.0I
6.55 83.0I
7.00 84.0I
7.05 85.0 I
7.10 86.0 I
7.15 87.0 I
7.20 88.0 I
7.25 89.0 I
7.30 90.0.I
7.35 91.0 I
7.40 92.0 I
7.45 93.0 I
7.50 94.0 I
7.55 95.0 I
8.00 96.0 I
8.05 97.0 I
8.10 98.0 I
8.15 99.0 I
8.20100.0.I
8.25101.0 I
8.30102.0 I
8.35103. 0I
8.40104. 0I
8.45105. 0I
8.50106. 0I
8.55107. 0I
9.00108. 0I
9.05109. 0I
9.10110. 0I
9.15111. 0I
9.20112. 0I
9.25113. 0I
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9.45117. 0I
9.50118. 0I

PLATE D-13

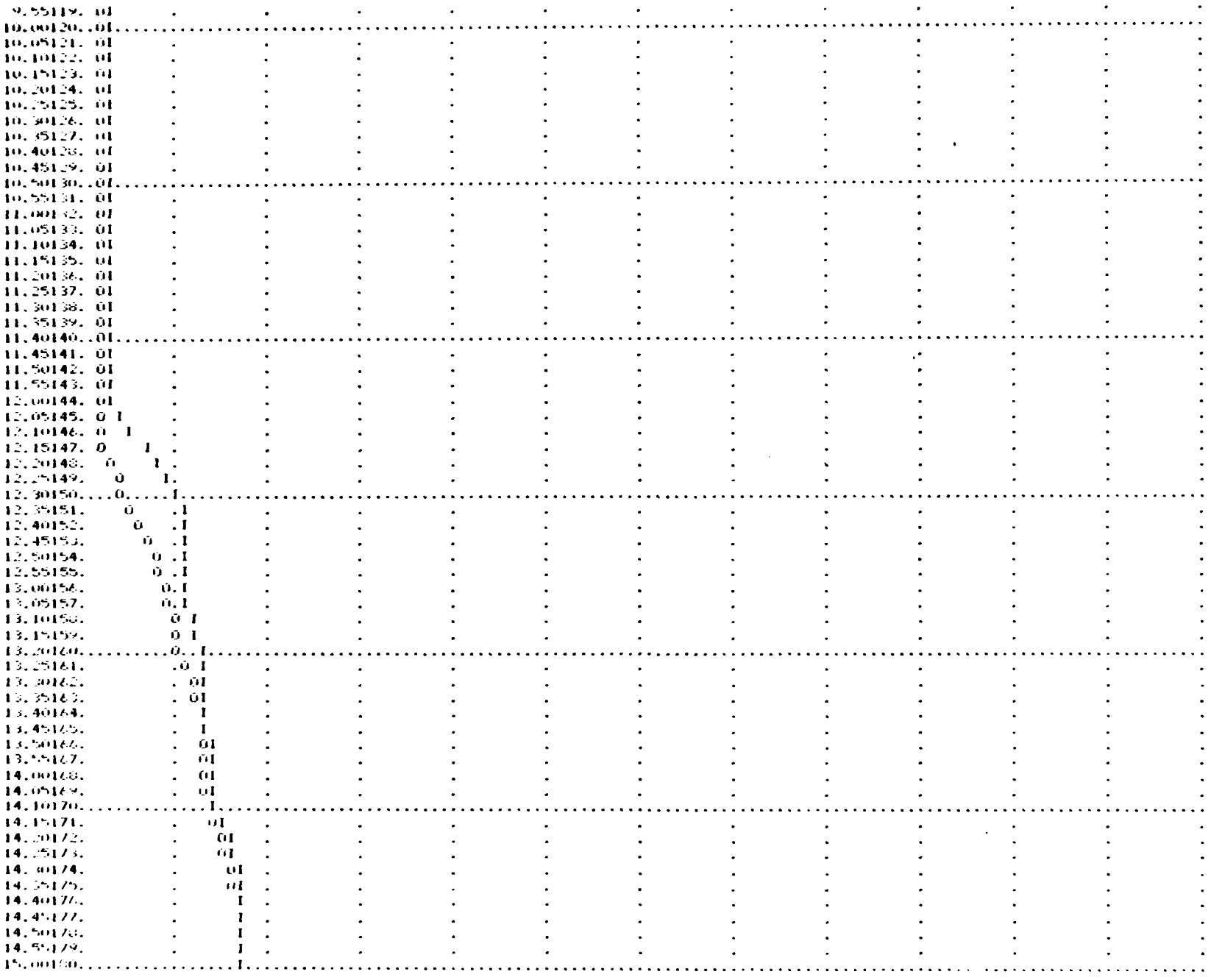


PLATE D-14

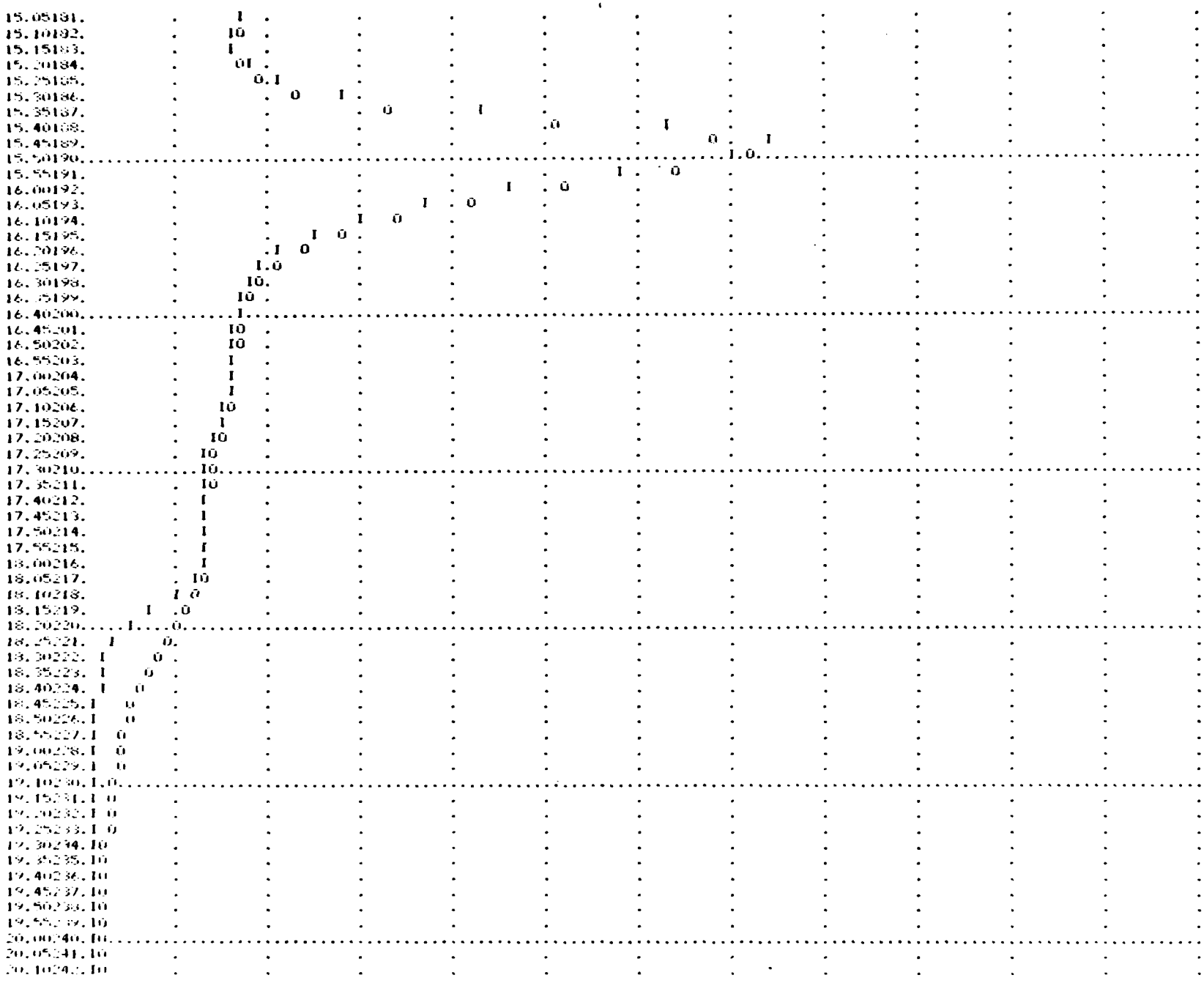
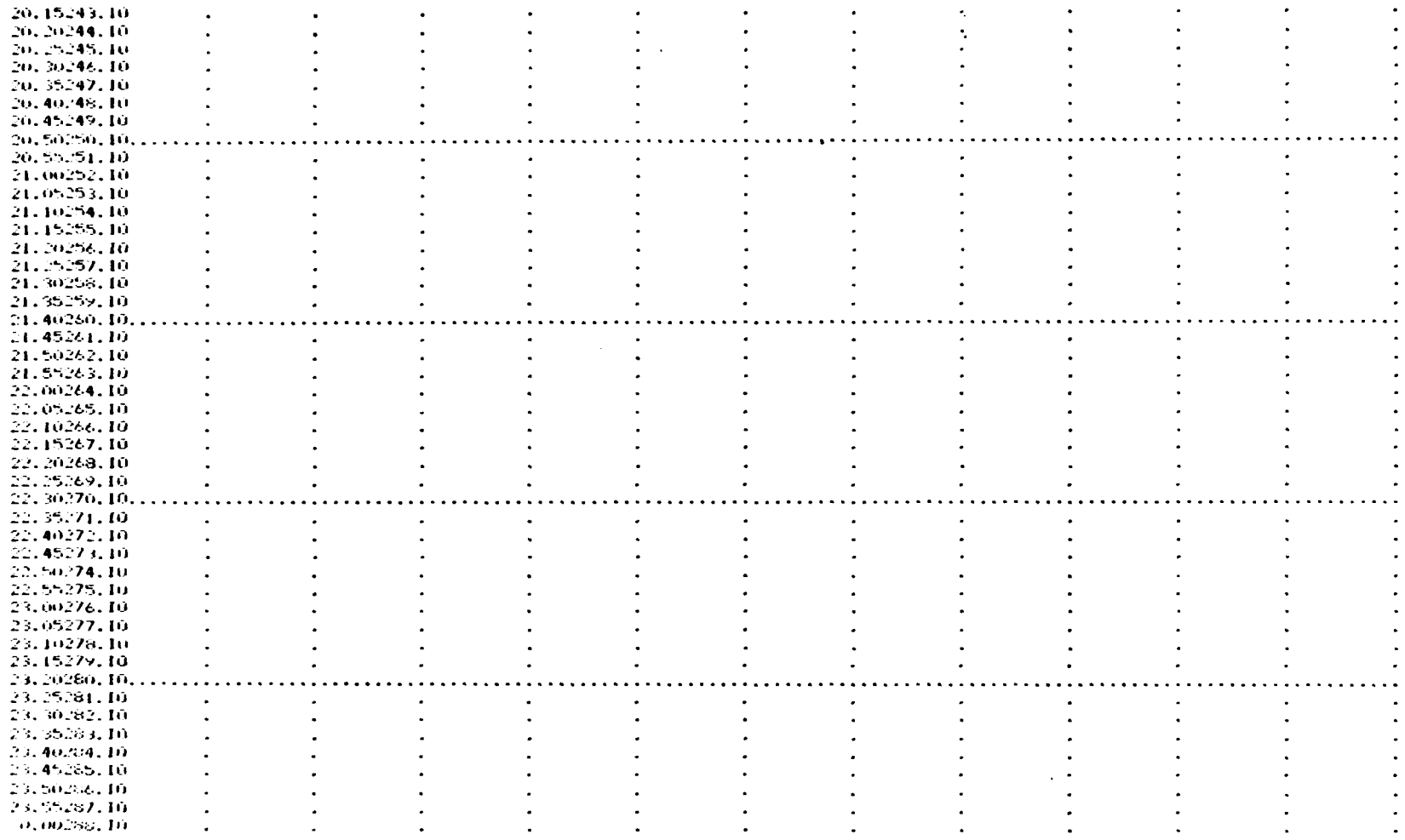


PLATE D-15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21.00252.10
21.05253.10
21.10254.10
21.15255.10
21.20256.10
21.25257.10
21.30258.10
21.35259.10
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21.50262.10
21.55263.10
22.00264.10
22.05265.10
22.10266.10
22.15267.10
22.20268.10
22.25269.10
22.30270.10
22.35271.10
22.40272.10
22.45273.10
22.50274.10
22.55275.10
23.00276.10
23.05277.10
23.10278.10
23.15279.10
23.20280.10
23.25281.10
23.30282.10
23.35283.10
23.40284.10
23.45285.10
23.50286.10
23.55287.10
0.00288.10

PLATE D-16

LIVN

STATION 000002, PLAN 1, RATIO 9 PMF

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	2.	2.	2.
2.	2.	2.	2.	2.	2.	3.	3.	3.	3.
3.	3.	3.	4.	4.	4.	5.	5.	5.	6.
6.	6.	6.	7.	8.	10.	12.	14.	16.	18.
20.	22.	24.	26.	27.	29.	30.	31.	33.	34.
35.	36.	37.	37.	38.	39.	40.	40.	41.	42.
42.	43.	46.	52.	60.	68.	75.	81.	87.	91.
96.	99.	103.	106.	109.	111.	113.	116.	119.	121.
123.	125.	126.	127.	128.	129.	130.	130.	131.	131.
132.	132.	132.	133.	133.	133.	134.	134.	134.	134.
134.	135.	135.	135.	137.	144.	160.	186.	220.	276.
340.	399.	424.	434.	440.	443.	447.	455.	471.	491.
508.	521.	529.	534.	537.	540.	541.	542.	545.	557.
582.	612.	637.	655.	667.	673.	677.	680.	681.	682.
678.	661.	652.	679.	768.	961.	1402.	2149.	2788.	2880.
2532.	2047.	1633.	1325.	1090.	924.	816.	748.	708.	682.
665.	654.	648.	645.	641.	628.	604.	574.	550.	533.
522.	515.	511.	509.	507.	506.	497.	458.	383.	304.
252.	211.	189.	167.	147.	129.	114.	105.	98.	91.
85.	79.	75.	71.	67.	64.	61.	58.	56.	54.
53.	52.	51.	50.	49.	49.	48.	47.	47.	46.
46.	45.	45.	45.	44.	44.	44.	43.	43.	43.
43.	43.	43.	43.	43.	43.	43.	43.	43.	43.
43.	43.	43.	43.	43.	43.	43.	43.	43.	43.
43.	43.	43.	43.	43.	43.	43.	43.		

STORAGE

6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	8.	8.	8.	8.	8.	8.
8.	8.	8.	8.	8.	8.	9.	9.	10.	10.
11.	11.	12.	12.	13.	13.	14.	14.	15.	15.
16.	16.	17.	17.	18.	18.	19.	19.	20.	21.
21.	22.	22.	23.	23.	24.	24.	24.	25.	25.
25.	25.	25.	26.	26.	26.	26.	26.	26.	26.
26.	26.	26.	26.	26.	26.	26.	27.	27.	27.
27.	27.	27.	27.	27.	27.	27.	27.	27.	27.
27.	27.	27.	27.	27.	27.	28.	28.	29.	30.
31.	32.	32.	32.	32.	32.	32.	32.	32.	32.
32.	32.	32.	32.	32.	32.	32.	32.	32.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
34.	34.	33.	33.	33.	34.	36.	38.	40.	40.
39.	38.	37.	36.	35.	34.	34.	33.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	32.	32.
32.	32.	32.	32.	32.	32.	32.	32.	32.	31.
30.	29.	29.	28.	27.	26.	26.	26.	25.	25.
24.	24.	24.	24.	23.	23.	23.	23.	23.	23.

PLATE D-17

23.	23.	23.	22.	22.	22.	22.	22.	22.	22.
22.	22.	22.	22.	22.	22.	22.	22.	22.	22.
22.	22.	22.	22.	22.	22.	22.	22.	22.	22.
22.	22.	22.	22.	22.	22.	22.	22.	22.	22.
22.	21.	21.	21.	21.	21.	21.	21.		

STAGE

979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1
979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1
979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1
979.1	979.1	979.1	979.1	979.1	979.1	979.2	979.2	979.2	979.2
979.3	979.3	979.3	979.3	979.4	979.4	979.4	979.4	979.5	979.5
979.5	979.6	979.6	979.6	979.7	979.7	979.7	979.8	979.8	979.9
979.9	979.9	980.0	980.0	980.0	980.1	980.1	980.1	980.2	980.2
980.2	980.3	980.3	980.4	980.5	980.7	980.9	981.1	981.4	981.6
981.9	982.2	982.4	982.7	982.9	983.2	983.4	983.6	983.9	984.1
984.3	984.5	984.8	985.0	985.2	985.4	985.6	985.8	986.0	986.2
986.4	986.6	986.8	986.9	987.1	987.2	987.4	987.5	987.5	987.6
987.7	987.8	987.8	987.9	987.9	988.0	988.0	988.0	988.1	988.1
988.1	988.1	988.1	988.1	988.2	988.2	988.2	988.2	988.2	988.2
988.2	988.2	988.2	988.2	988.2	988.2	988.2	988.2	988.2	988.2
988.2	988.2	988.2	988.2	988.2	988.3	988.5	988.7	989.1	989.3
989.5	989.6	989.7	989.7	989.7	989.7	989.7	989.7	989.8	989.8
989.8	989.8	989.8	989.8	989.9	989.9	989.9	989.9	989.9	989.9
989.9	990.0	990.0	990.0	990.0	990.0	990.0	990.0	990.0	990.0
990.0	990.0	990.0	990.0	990.1	990.3	990.7	991.3	991.7	991.8
991.5	991.2	990.9	990.7	990.4	990.3	990.2	990.1	990.1	990.0
990.0	990.0	990.0	990.0	990.0	990.0	989.9	989.9	989.9	989.8
989.8	989.8	989.8	989.8	989.8	989.8	989.8	989.7	989.6	989.4
989.2	989.0	988.8	988.6	988.3	988.2	988.0	987.9	987.7	987.6
987.5	987.4	987.3	987.3	987.2	987.2	987.1	987.1	987.0	987.0
987.0	986.9	986.9	986.9	986.9	986.8	986.8	986.8	986.8	986.8
986.8	986.8	986.7	986.7	986.7	986.7	986.7	986.7	986.7	986.7
986.7	986.7	986.7	986.7	986.7	986.6	986.6	986.6	986.6	986.6
986.6	986.6	986.6	986.6	986.6	986.6	986.6	986.6	986.6	986.6
986.6	986.5	986.5	986.5	986.5	986.5	986.5	986.5		

PEAK OUTFLOW IS 2880. AT TIME 15.83 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2880.	746.	224.	224.	44086.
CMS	82.	21.	6.	6.	1248.
INCHES		23.53	28.20	28.20	28.20
MM		597.77	716.24	716.24	716.24
AC-FT		370.	443.	443.	443.
THOUS CU M		456.	547.	547.	547.

PLATE D-18

RIVER A

STATION00000002

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

	0.	400.	800.	1200.	1600.	2000.	2400.	2800.	3200.	0.	0.	0.	0.
.05	1I	.	.	.	.	.	.	.	.	.	.	.	.
.10	2I	.	.	.	.	.	.	.	.	.	.	.	.
.15	3I	.	.	.	.	.	.	.	.	.	.	.	.
.20	4I	.	.	.	.	.	.	.	.	.	.	.	.
.25	5I	.	.	.	.	.	.	.	.	.	.	.	.
.30	6I	.	.	.	.	.	.	.	.	.	.	.	.
.35	7I	.	.	.	.	.	.	.	.	.	.	.	.
.40	8I	.	.	.	.	.	.	.	.	.	.	.	.
.45	9I	.	.	.	.	.	.	.	.	.	.	.	.
.50	10I	.	.	.	.	.	.	.	.	.	.	.	.
.55	11I	.	.	.	.	.	.	.	.	.	.	.	.
1.00	12I	.	.	.	.	.	.	.	.	.	.	.	.
1.05	13I	.	.	.	.	.	.	.	.	.	.	.	.
1.10	14I	.	.	.	.	.	.	.	.	.	.	.	.
1.15	15I	.	.	.	.	.	.	.	.	.	.	.	.
1.20	16I	.	.	.	.	.	.	.	.	.	.	.	.
1.25	17I	.	.	.	.	.	.	.	.	.	.	.	.
1.30	18I	.	.	.	.	.	.	.	.	.	.	.	.
1.35	19I	.	.	.	.	.	.	.	.	.	.	.	.
1.40	20I	.	.	.	.	.	.	.	.	.	.	.	.
1.45	21I	.	.	.	.	.	.	.	.	.	.	.	.
1.50	22I	.	.	.	.	.	.	.	.	.	.	.	.
1.55	23I	.	.	.	.	.	.	.	.	.	.	.	.
2.00	24I	.	.	.	.	.	.	.	.	.	.	.	.
2.05	25I	.	.	.	.	.	.	.	.	.	.	.	.
2.10	26I	.	.	.	.	.	.	.	.	.	.	.	.
2.15	27I	.	.	.	.	.	.	.	.	.	.	.	.
2.20	28I	.	.	.	.	.	.	.	.	.	.	.	.
2.25	29I	.	.	.	.	.	.	.	.	.	.	.	.
2.30	30I	.	.	.	.	.	.	.	.	.	.	.	.
2.35	31I	.	.	.	.	.	.	.	.	.	.	.	.
2.40	32I	.	.	.	.	.	.	.	.	.	.	.	.
2.45	33I	.	.	.	.	.	.	.	.	.	.	.	.
2.50	34I	.	.	.	.	.	.	.	.	.	.	.	.
2.55	35I	.	.	.	.	.	.	.	.	.	.	.	.
3.00	36I	.	.	.	.	.	.	.	.	.	.	.	.
3.05	37I	.	.	.	.	.	.	.	.	.	.	.	.
3.10	38I	.	.	.	.	.	.	.	.	.	.	.	.
3.15	39I	.	.	.	.	.	.	.	.	.	.	.	.
3.20	40I	.	.	.	.	.	.	.	.	.	.	.	.
3.25	41I	.	.	.	.	.	.	.	.	.	.	.	.
3.30	42I	.	.	.	.	.	.	.	.	.	.	.	.
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3.40	44I	.	.	.	.	.	.	.	.	.	.	.	.
3.45	45I	.	.	.	.	.	.	.	.	.	.	.	.
3.50	46I	.	.	.	.	.	.	.	.	.	.	.	.
3.55	47I	.	.	.	.	.	.	.	.	.	.	.	.
4.00	48I	.	.	.	.	.	.	.	.	.	.	.	.
4.05	49I	.	.	.	.	.	.	.	.	.	.	.	.
4.10	50I	.	.	.	.	.	.	.	.	.	.	.	.
4.15	51I	.	.	.	.	.	.	.	.	.	.	.	.
4.20	52I	.	.	.	.	.	.	.	.	.	.	.	.
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4.30	54I	.	.	.	.	.	.	.	.	.	.	.	.
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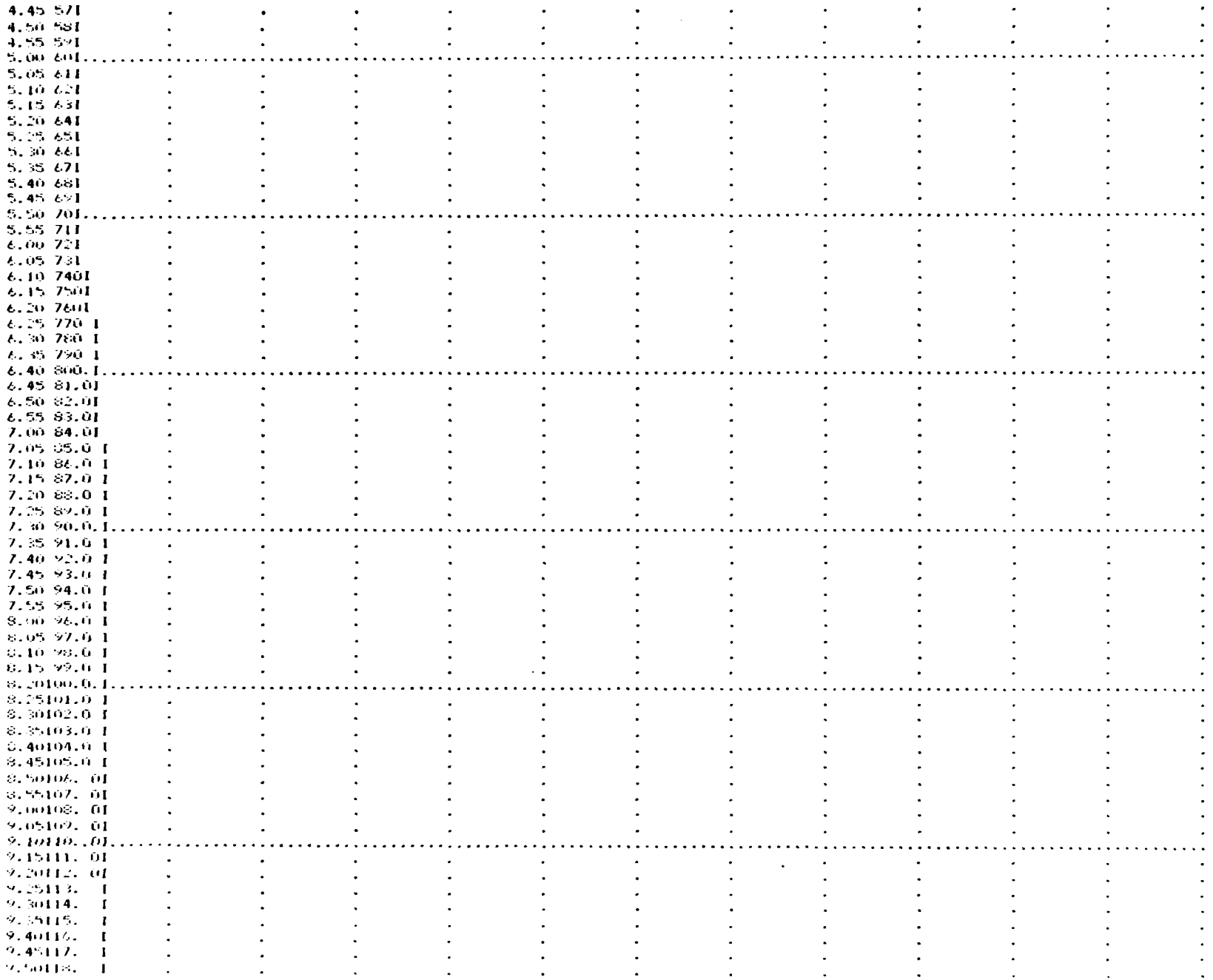
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5.30 66I
5.35 67I
5.40 68I
5.45 69I
5.50 70I
5.55 71I
6.00 72I
6.05 73I
6.10 74OI
6.15 75OI
6.20 76OI
6.25 770 I
6.30 780 I
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6.55 83.0I
7.00 84.0I
7.05 85.0 I
7.10 86.0 I
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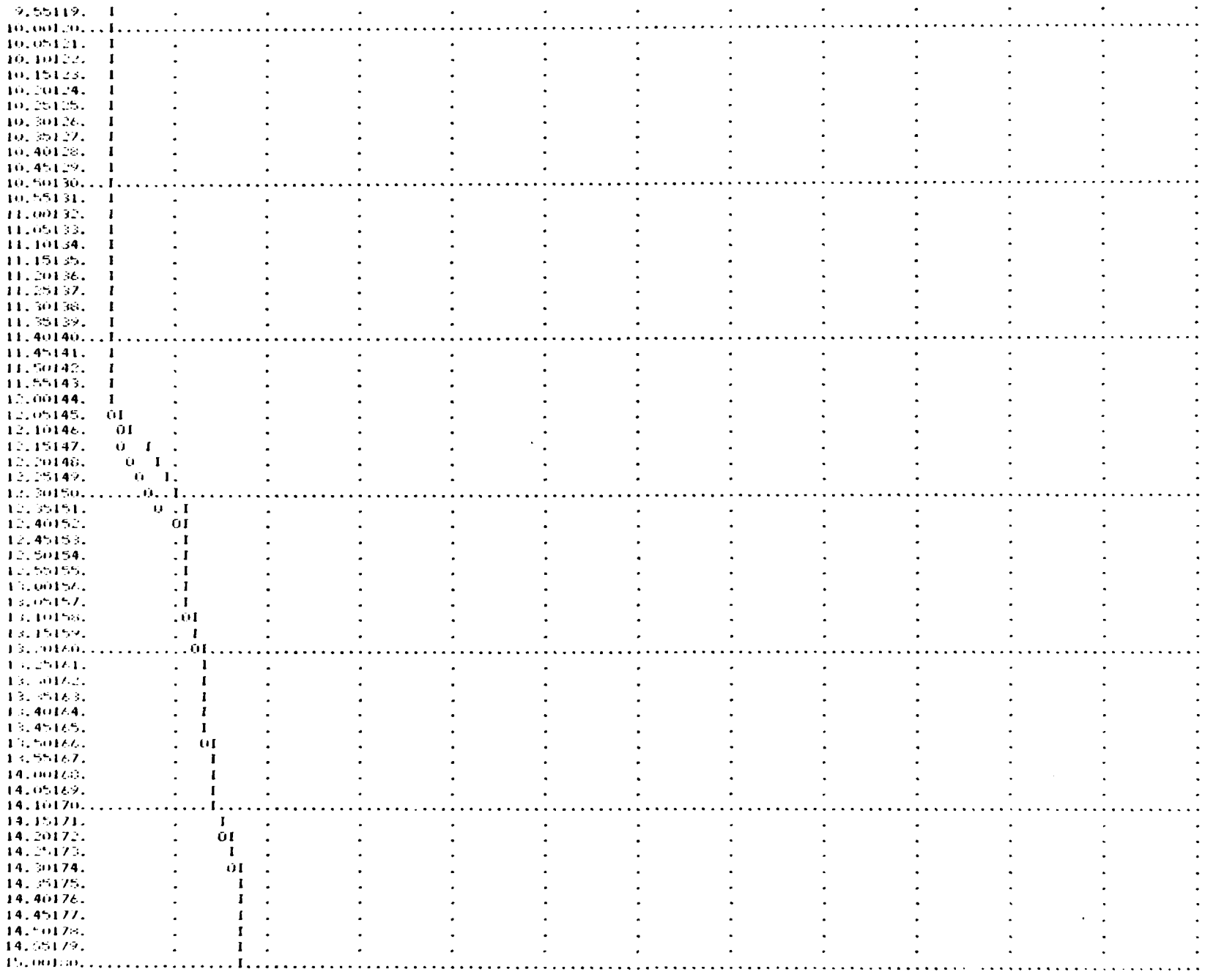
PLATE D-20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10.40128.
10.45129.
10.50130.
10.55131.
11.00132.
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11.30138.
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11.40140.
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12.25149.
12.30150.
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12.40152.
12.45153.
12.50154.
12.55155.
13.00156.
13.05157.
13.10158.
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13.20160.
13.25161.
13.30162.
13.35163.
13.40164.
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13.50166.
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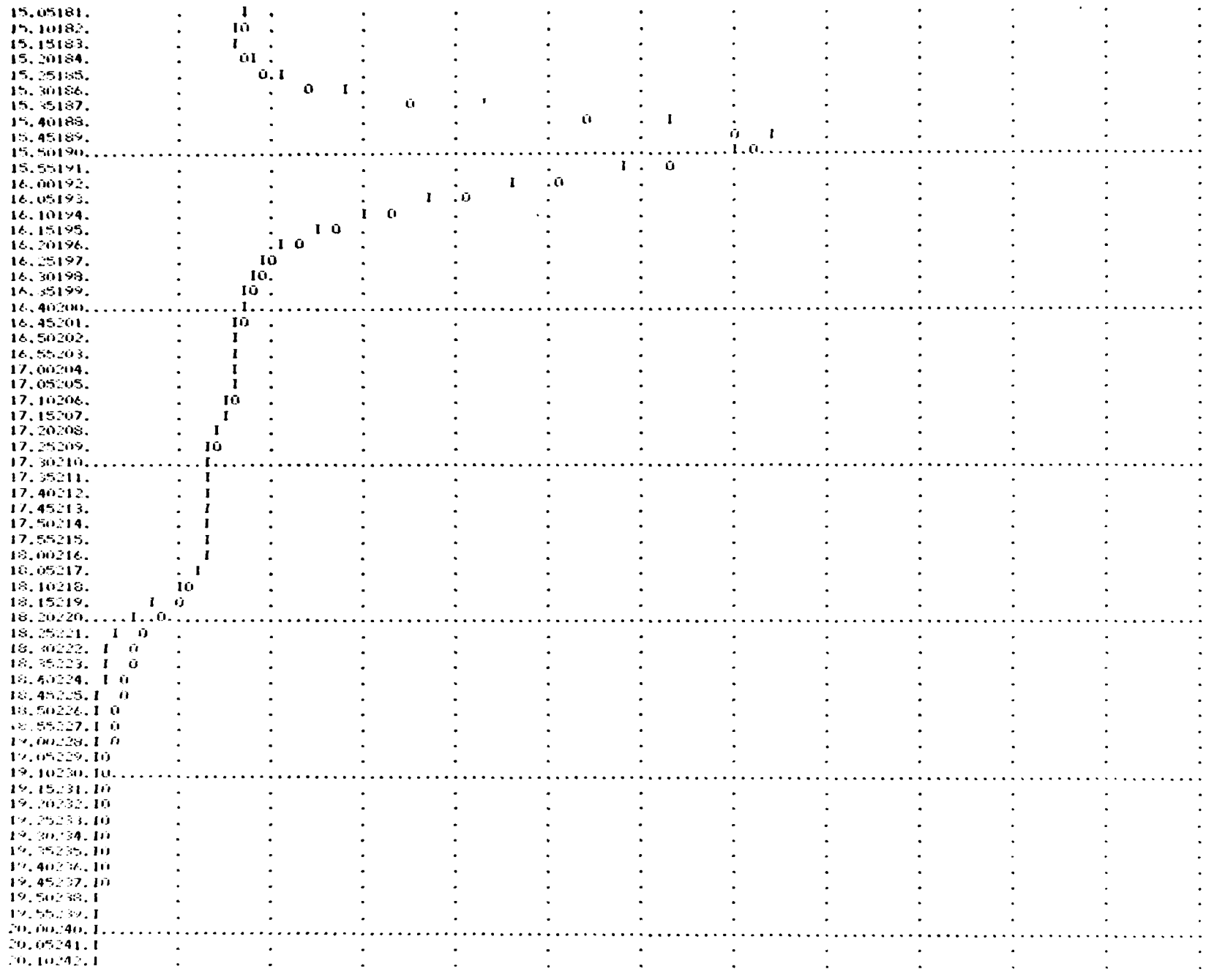
PLATE D-21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19.05229.
19.10230.
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19.55239.
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20.05241.
20.10242.

PLATE D-22

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20.50250.1
20.55251.1
21.00252.1
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21.10254.1
21.15255.1
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21.30258.1
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0.00288.1

PLATE D-23

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1 .10	RATIO 2 .20	RATIO 3 .25	RATIO 4 .30	RATIO 5 .35	RATIO 6 .40	RATIO 7 .45	RATIO 8 .50	RATIO 9 1.00
HYDROGRAPH AT	000001	.30	1	294.	589.	736.	883.	1030.	1178.	1325.	1472.	2944.
		(.76)		(8.34)(	16.67)(	20.84)(	25.01)(	29.18)(	33.35)(	37.51)(	41.68)(	83.37)
ROUTED TO	000002	.30	1	101.	511.	698.	855.	1002.	1147.	1291.	1436.	2880.
		(.76)		(2.86)(	14.47)(	19.78)(	24.21)(	28.37)(	32.48)(	36.56)(	40.66)(	81.55)

PLATE D-24

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	979.10	979.10	989.20
STORAGE	6.	6.	30.
OUTFLOW	0.	0.	247.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	987.79	0.00	25.	101.	0.00	16.25	0.00
.20	989.81	.61	32.	511.	.58	15.92	0.00
.25	990.06	.86	33.	698.	.83	15.83	0.00
.30	990.22	1.02	34.	855.	1.00	15.83	0.00
.35	990.37	1.17	34.	1002.	1.33	15.83	0.00
.40	990.50	1.30	35.	1147.	2.75	15.83	0.00
.45	990.63	1.43	35.	1291.	3.33	15.83	0.00
.50	990.75	1.55	36.	1436.	4.50	15.83	0.00
1.00	991.77	2.57	40.	2880.	6.00	15.83	0.00

PLATE D-25

```
A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2       H & H ANALYSIS OF SAFETY OF EARL HALL DAM-MO 11038
A3       RATIOS OF PMF ROUTED THROUGH THE RESERVOIR
B 000288000000000000005                          000000000000000000000003
B1000005
J 000001000000500000001
J1    .13      .14      .15      .16      .17
K 0000000000001                  000000000000000000000001
K1       CALCULATION OF INFLOW HYDROGRAPH TO RES 11038
M 000001000000020000.295         0000.295000001.0                  00000001
P 000000000023.70000010200000121000001 30
T                                                    -1.0    -88.0
W2       0000.226
X 000000    -.0100000001
K 000001000000002                000000020000000000000001
K1       ROUTED FLOWS THRU RESERVOIR 11038
Y                          000000010000000 1
Y1000001                                            -979.1       -1
Y40979.000000980000009810000098200000983000009840000098500000986000986.700000987
Y4000988000000989000989.500000990000990.500000991000009920000099300000994
Y500000000000003.500000013000000210000002800003 3.5000037.5000000410000 43.5000054.5
Y500011300000211000003020000048400000700000009070000139000001993000026 75
$A000000000001.4900003.7900007.81
$E000965000009800000099000001000
$$0979.1
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$L000025000000630000008700000107000001450000015500000162000001760000018300000189
$V0989.2000989.4000989.6000989.8000990.0000990.5000991.0000992.0000993.0000994.0
K 000099
A
A
A
A
A
```

PLATE D-26

KVN

STATION 000002, PLAN 1, RATIO 2 OUTLET

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	2.
2.	2.	2.	2.	3.	3.	3.	3.	3.	4.
4.	5.	5.	6.	6.	6.	7.	7.	8.	8.
8.	9.	9.	9.	10.	10.	10.	11.	11.	11.
11.	12.	12.	12.	12.	13.	13.	13.	13.	13.
13.	14.	14.	14.	14.	14.	14.	15.	15.	15.
15.	15.	15.	15.	15.	15.	16.	16.	16.	16.
16.	16.	16.	16.	16.	17.	17.	18.	19.	20.
21.	22.	23.	24.	25.	26.	27.	27.	28.	29.
30.	31.	31.	32.	33.	34.	34.	34.	35.	35.
36.	37.	37.	38.	38.	39.	39.	40.	40.	41.
41.	42.	42.	43.	43.	48.	63.	92.	134.	183.
216.	239.	237.	222.	205.	191.	177.	164.	152.	142.
133.	125.	119.	113.	110.	108.	105.	102.	99.	96.
93.	91.	88.	86.	84.	83.	81.	79.	78.	70.
65.	59.	53.	50.	46.	43.	43.	43.	43.	42.
42.	42.	41.	41.	41.	40.	40.	40.	39.	39.
39.	38.	38.	38.	39.	37.	37.	37.	36.	36.
35.	35.	35.	34.	34.	34.	33.	33.	33.	32.
32.	31.	31.	30.	30.	29.	29.	29.	28.	28.
27.	27.	26.	26.	25.	25.	24.	24.	23.	23.
23.	22.	22.	21.	21.	20.	20.	20.		

STORAGE

6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
8.	8.	8.	8.	8.	8.	8.	8.	8.	8.
8.	8.	8.	8.	8.	9.	9.	9.	9.	9.
9.	9.	9.	9.	9.	9.	9.	9.	9.	9.
9.	9.	9.	9.	9.	9.	9.	9.	9.	9.
9.	9.	9.	10.	10.	10.	10.	10.	10.	10.
10.	10.	10.	10.	10.	10.	10.	10.	10.	11.
11.	11.	11.	12.	12.	12.	12.	13.	13.	13.
13.	14.	14.	14.	15.	15.	15.	16.	16.	16.
16.	17.	17.	18.	18.	18.	19.	19.	19.	20.
20.	21.	21.	21.	22.	22.	23.	25.	27.	28.
29.	30.	30.	30.	29.	29.	28.	28.	27.	27.
27.	26.	26.	26.	26.	26.	25.	25.	25.	25.
25.	25.	25.	24.	24.	24.	24.	24.	24.	24.
23.	23.	23.	22.	22.	22.	22.	21.	21.	21.
21.	20.	20.	20.	20.	19.	19.	19.	19.	18.

PLATE D-27

18.	18.	18.	18.	17.	.	17.	17.	17.	16.
16.	16.	16.	15.	15.	15.	15.	15.	15.	14.
14.	14.	14.	14.	13.	13.	13.	13.	13.	13.
13.	12.	12.	12.	12.	12.	12.	12.	11.	11.
11.	11.	11.	11.	11.	11.	11.	10.		

STAGE

979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1
979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1
979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1
979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1
979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979,1	979.1
979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.1	979.2
979.2	979.2	979.2	979.2	979.2	979.2	979.2	979.2	979.2	979.2
979.2	979.2	979.2	979.2	979.3	979.3	979.3	979.4	979.4	979.5
979.5	979.6	979.6	979.7	979.7	979.8	979.8	979.9	980.0	980.0
980.1	980.1	980.2	980.2	980.3	980.3	980.3	980.4	980.4	980.5
980.5	980.5	980.6	980.6	980.6	980.7	980.7	980.7	980.8	980.8
980.8	980.9	980.9	980.9	980.9	981.0	981.0	981.0	981.0	981.0
981.1	981.1	981.1	981.1	981.1	981.2	981.2	981.2	981.2	981.2
981.2	981.3	981.3	981.3	981.3	981.3	981.3	981.3	981.3	981.4
981.4	981.4	981.4	981.4	981.4	981.5	981.5	981.6	981.7	981.9
982.0	982.1	982.3	982.4	982.5	982.7	982.8	982.9	983.1	983.2
983.3	983.5	983.6	983.7	983.9	984.0	984.1	984.2	984.4	984.5
984.6	984.8	984.9	985.1	985.2	985.4	985.5	985.7	985.8	985.9
986.1	986.2	986.3	986.5	986.6	986.8	987.2	987.6	988.2	988.7
989.0	989.2	989.1	989.1	988.9	988.8	988.7	988.5	988.4	988.3
988.2	988.1	988.1	988.0	988.0	987.9	987.9	987.8	987.8	987.7
987.7	987.6	987.6	987.5	987.5	987.5	987.5	987.4	987.4	987.3
987.2	987.1	987.0	986.9	986.8	986.7	986.6	986.5	986.4	986.3
986.2	986.2	986.1	986.0	985.9	985.8	985.7	985.6	985.5	985.5
985.4	985.3	985.2	985.1	985.0	984.9	984.8	984.8	984.7	984.6
984.5	984.4	984.3	984.2	984.2	984.1	984.0	983.9	983.8	983.7
983.7	983.6	983.5	983.4	983.3	983.3	983.2	983.1	983.0	983.0
982.9	982.8	982.7	982.7	982.6	982.5	982.5	982.4	982.3	982.3
982.2	982.2	982.1	982.0	982.0	981.9	981.9	981.8		

PEAK OUTFLOW IS 239. AT TIME 16.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	239.	83.	30.	30.	8704.
CMS	7.	2.	1.	1.	246.
INCHES		2.62	3.81	3.81	3.81
MM		66.46	96.82	96.82	96.82
AC-FT		41.	60.	60.	60.
THOUS CU M		51.	74.	74.	74.

PLATE D-28

«OVF»

STATION000002

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

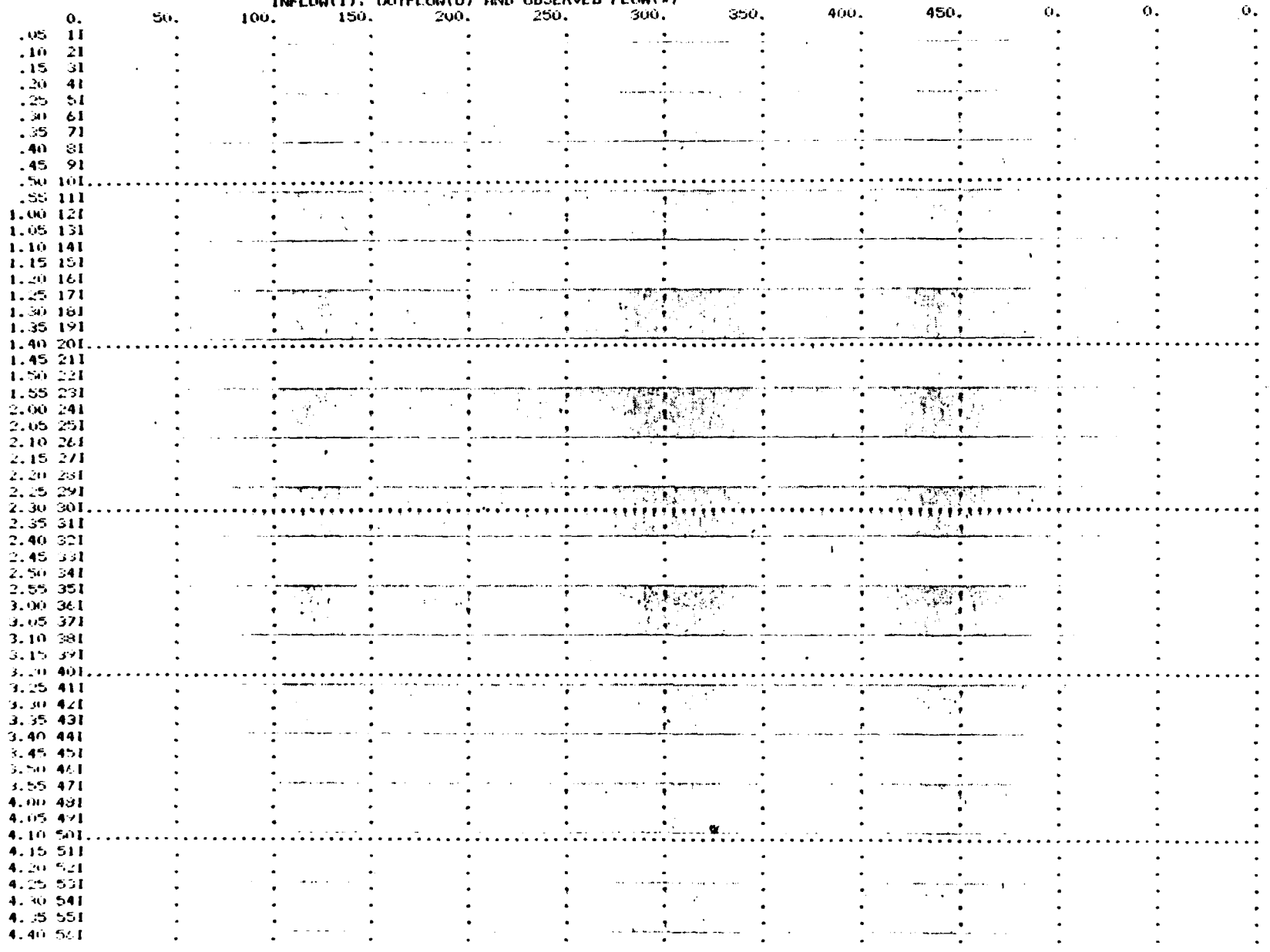
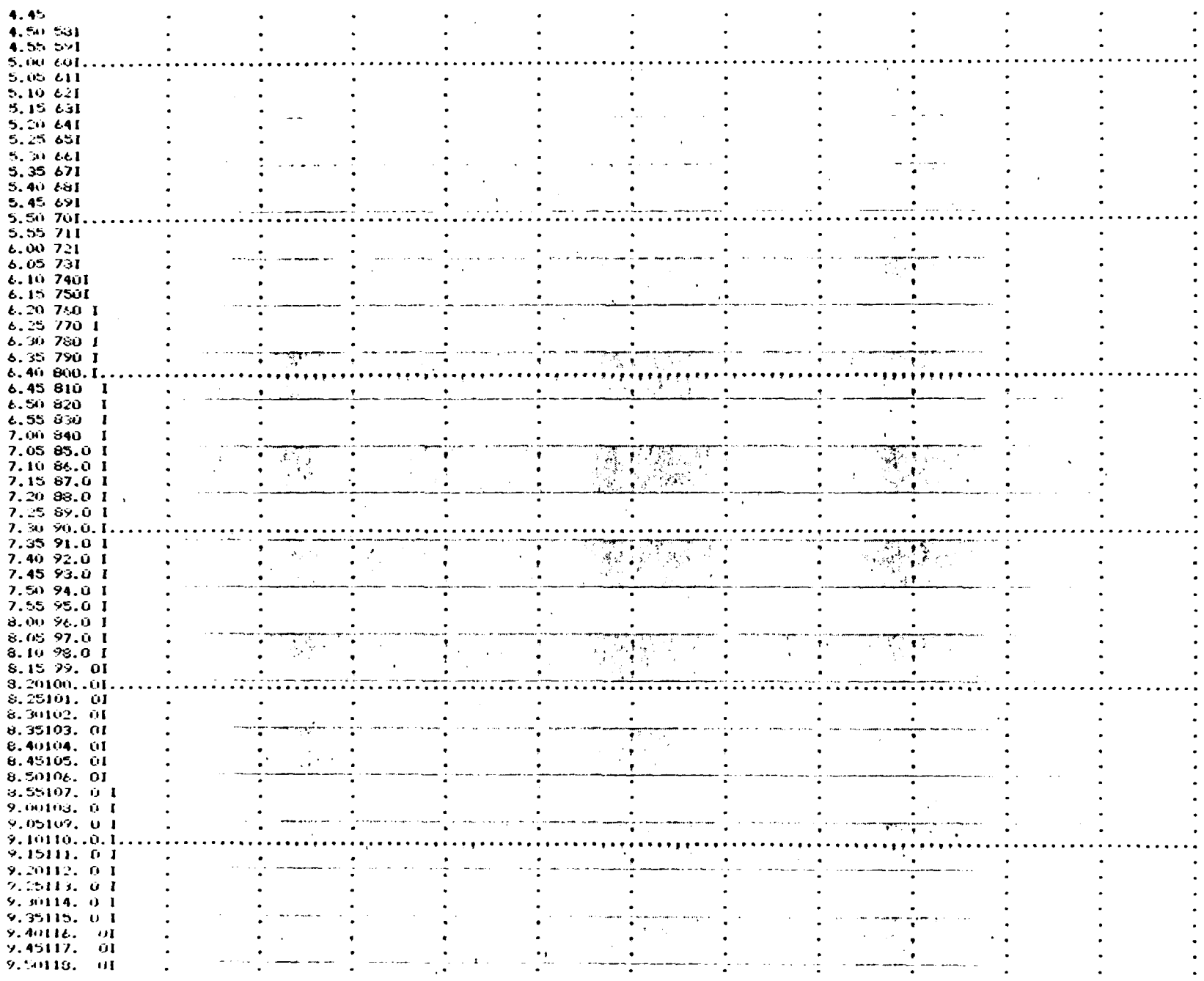


PLATE D-29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5.05 611
5.10 621
5.15 631
5.20 641
5.25 651
5.30 661
5.35 671
5.40 681
5.45 691
5.50 701
5.55 711
6.00 721
6.05 731
6.10 740I
6.15 750I
6.20 760 I
6.25 770 I
6.30 780 I
6.35 790 I
6.40 800.I
6.45 810 I
6.50 820 I
6.55 830 I
7.00 840 I
7.05 85.0 I
7.10 86.0 I
7.15 87.0 I
7.20 88.0 I
7.25 89.0 I
7.30 90.0.I
7.35 91.0 I
7.40 92.0 I
7.45 93.0 I
7.50 94.0 I
7.55 95.0 I
8.00 96.0 I
8.05 97.0 I
8.10 98.0 I
8.15 99. 0I
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PLATE D-30

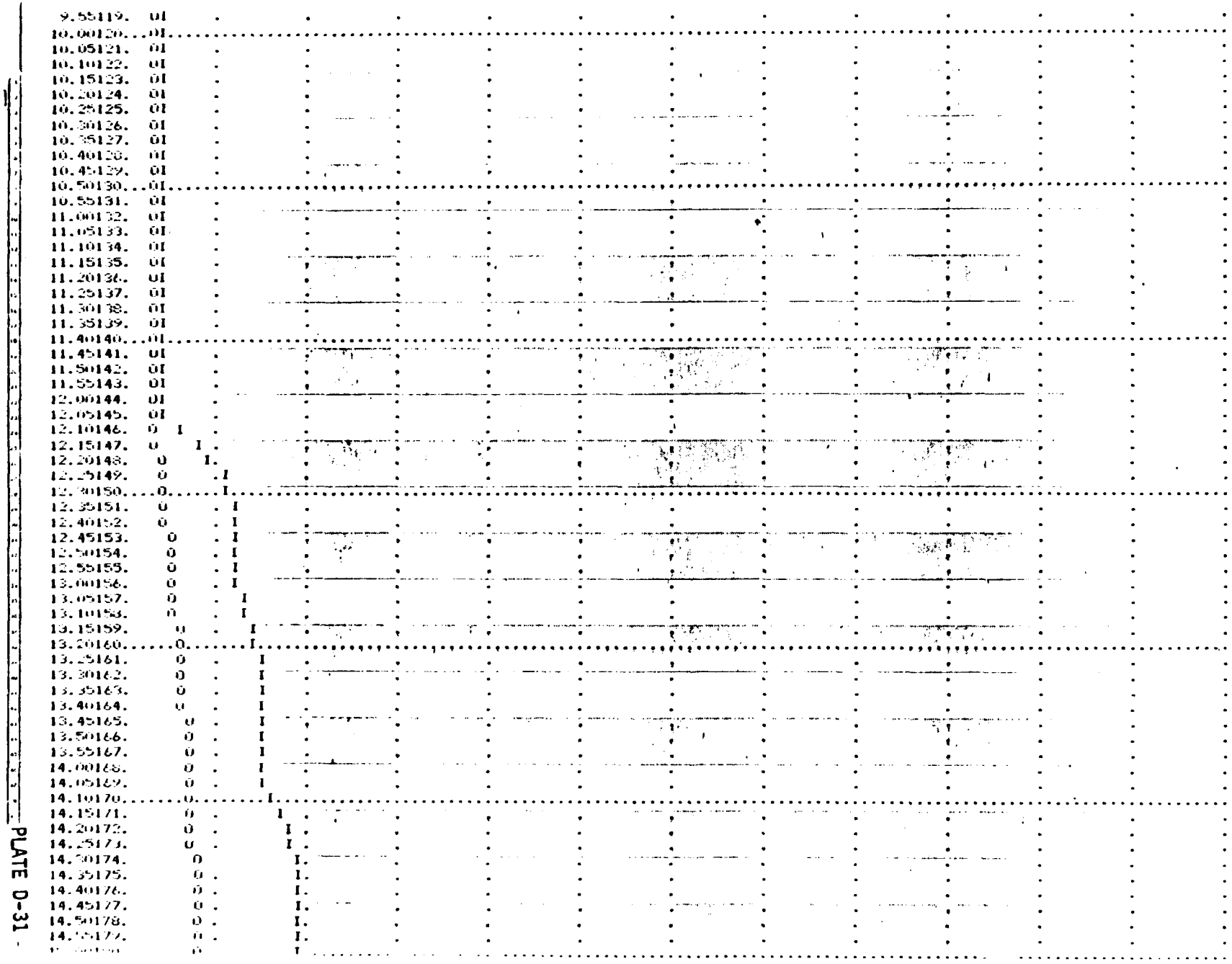
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PLATE D-31

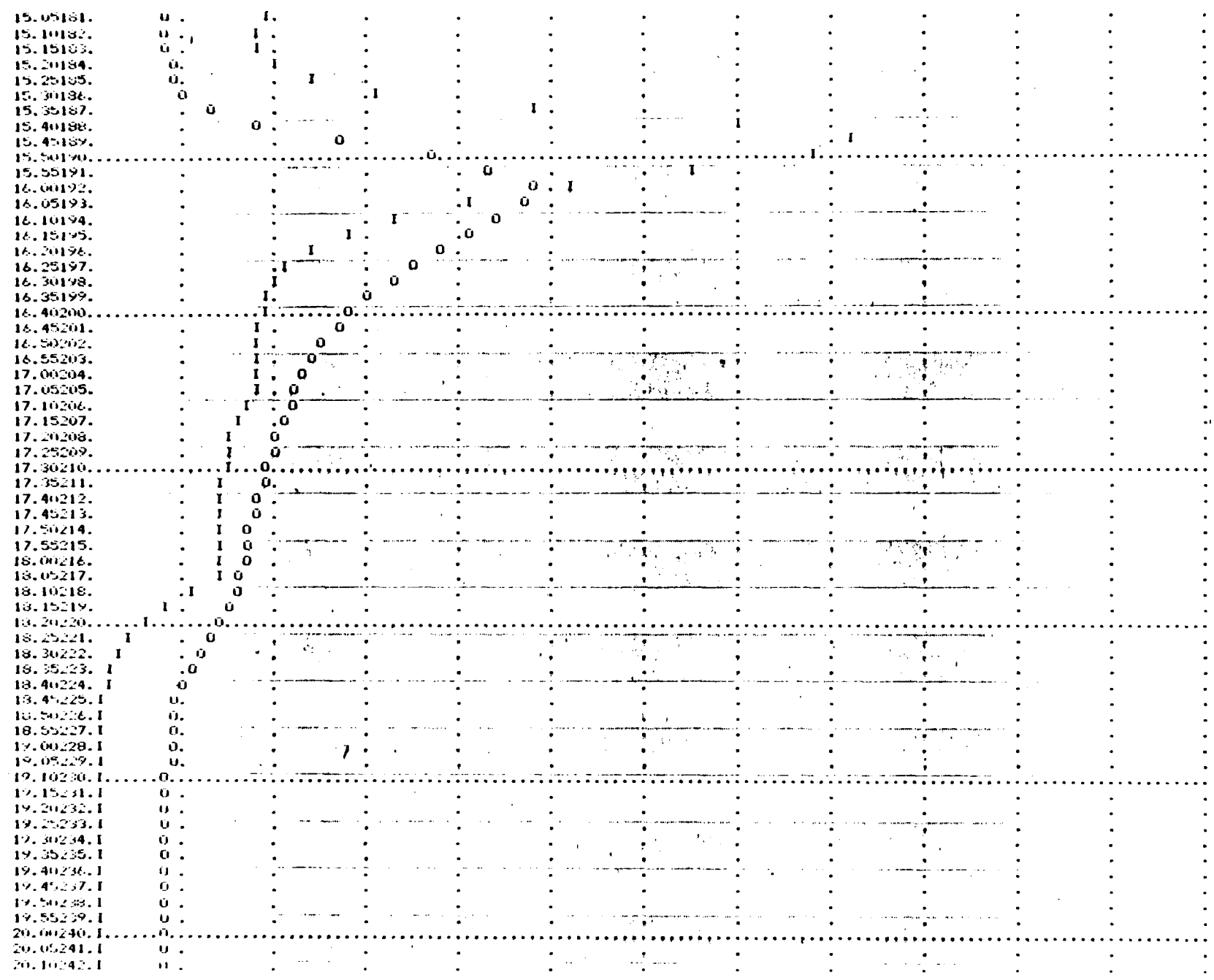
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PLATE D-32

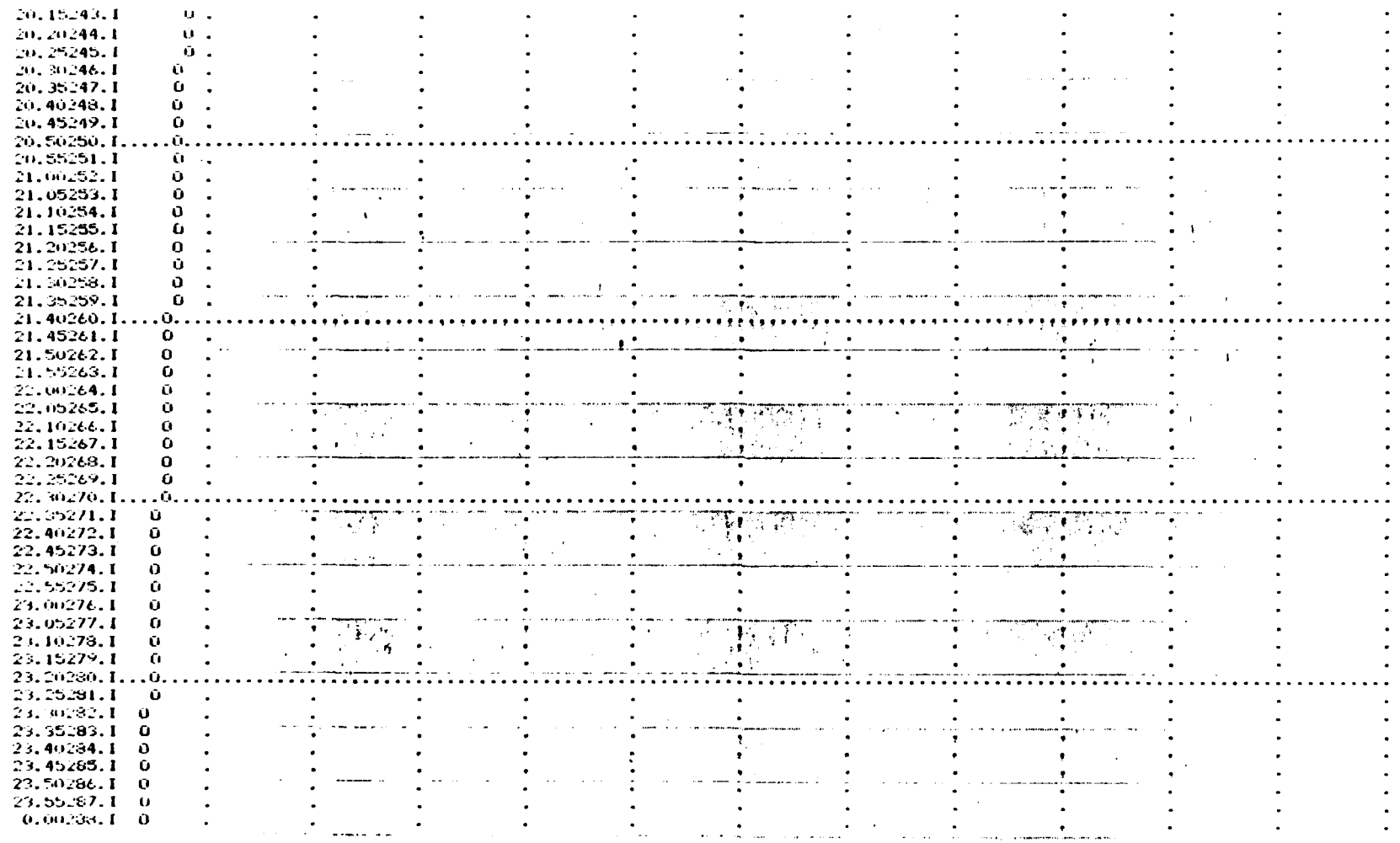
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PLATE D-33

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	979.10	979.10	989.20
STORAGE	6.	6.	30.
OUTFLOW	0.	0.	247.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.13	988.88	0.00	29.	199.	0.00	16.08	0.00
.14	989.15	0.00	30.	239.	0.00	16.00	0.00
.15	989.37	.17	31.	287.	.25	16.00	0.00
.16	989.51	.31	31.	329.	.42	16.00	0.00
.17	989.62	.42	32.	392.	.42	15.92	0.00

PLATE D-34

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .13	RATIO 2 .14	RATIO 3 .15	RATIO 4 .16	RATIO 5 .17
HYDROGRAPH AT	000001	.30	1	383.	412.	442.	471.	500.
		(.76)		(10.84)(	11.67)(	12.50)(	13.34)(	14.17)(
ROUTED TO	000002	.30	1	199.	239.	287.	329.	392.
		(.76)		(5.64)(	6.77)(	8.12)(	9.33)(	11.09)(

PLATE D-35


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